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NEW ZEALAND'S POPULATION PROSPECTS

G. N. CALVERT

TODAY it is the atomic bomb and the world food situation which have captured the headlines. In one year the former has upset our ole conception of war, brought important tensions into international ations, and made even more urgent the establishment of an effective rld government, while at the same time relief of temporary world d shortages has filled the thoughts alike of the common man and the tesman working at the international level.

Had we the power to see the whole of the emerging problems of world in perspective, and to ponder their long-term effects on man destinies, it is possible that we might come to shift at least some our attention instead to world population matters. Because the wth and decay of populations take place gradually, almost imper- ptibly—in the background, as it were—and are complicated by ny other factors such as relative industrial development, they tend be practically ignored. But it is safe to expect that the great and mplex problems of relative population growth will figure pro- nently among the principal problems with which the World vernment of the future will have to grapple.

It is not the purpose of this article to do more than touch on these at world problems of population. Attention will rather be focussed New Zealand's own population, its structure and dynamics, its tribution and drifts, and its fundamental role as a factor in national velopment. Some interesting questions on possible ways in which pulation growth and distribution may need to be influenced in the ure will be raised in the final paragraphs.

WORLD POPULATION TRENDS

The world may be regarded for demographic purposes as being ided roughly into three major population areas—the area of arrested growth or decline, the area of medium growth, and the area of uncontrolled growth.[1]

It has been the common experience of all countries which have become industrialised that the process of industrialisation has been accompanied by a cutting down of death rates and a consequent sudden upsurge of population which has later been arrested. England's population quadrupled during the 19th century.

Japan's experience is significant. Starting much later to industrialise, Japan soon experienced a great increase of population, and with it of national vitality and ambition. With large numbers coming forward in the younger and military age groups, it was in a position to face very heavy casualties without losing power. The birth rate seems to have passed the peak in the 1920's, however, (as England's did in the 1870's) and, while still high, has begun to decline toward levels more comparable with those of European nations. Meanwhile Japan's manpower will remain for many years an important aspect of its military potential.

It should be noted in particular that many of the large countries which are already growing in numbers at a rapid rate are also in the process of industrialising, thus paving the way for the building up of tremendous power. Russia's case is too well known to need further comment. What its relative strength will be in another half-century compared with that of, say, the United States of America, is a matter which calls for serious thought. How the relative power of China may have grown in the same period, if her industrial development proceeds rapidly, is a no less sobering thought.

AN 'OPTIMUM POPULATION' FIGURE FOR NEW ZEALAND?

The 'optimum population' for any country is usually regarded as the size of population which can best utilise the physical resources

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[1] The area of *arrested* growth or decline includes most of northwestern Europe, the Scandinavian countries, England, Canada, U.S.A., Australia and New Zealand. Up to 1935 it was the common experience of all these countries that birth rates had long been falling, and in many cases the net reproduction rate had fallen below the level necessary for continued growth or even maintenance at a stationary level. France, Sweden, and England were among the countries with the lowest reproduction rates. Since 1935 the falling tendency seems to have halted in several countries, and a period of stability set in until, under the changed conditions of the war, birth rates have fluctuated at rather higher levels.

The area of *medium* growth embraces southern and eastern Europe, the U.S.S.R., the Balkan states and the South American countries.

The area of *uncontrolled* growth includes India, China, and indeed practically the whole of Asia with its more backward peoples and forms of civilisation. India's population is increasing by some six millions per annum. A Chinese woman normally bears the maximum possible number of children. Death rates are high. Periodical famines act as one of the main checks to total growth. To draw off population from these areas by emigration would not relieve the pressure of population, but would only make room for still faster growth.

the country whilst enabling the highest possible material standard of
to be maintained for the population as a whole. A strategist or a
tesman would tend to take a rather broader view than this, and would
lude considerations relating to world population pressures and
nds, that is, to factors *external* to the country itself.

It would appear that in New Zealand's case the following principal
guments apply: (1) The farming industries are highly productive on a
capita basis—more so than are most other industries in this country,
farming industries in other countries. At the same time, much of the
minion's available land is insufficiently farmed at the present time.
larger labour force on the land, combined with the development of
re intensive forms of cultivation, has been strongly advocated
the best informed quarters, the ultimate increase in the farm labour
ce envisaged being of the order of one-third. (See, for example, the
ent evidence given by the Agriculture Department to the Parlia-
ntary Committee on Population.) (2) The farming industries do
t provide productive employment for the female section of the labour
ce, as do most of the more balanced combinations of urban occupa-
ns. (3) The farming industries are moreover subject to seasonal
ings of employment, to irregular fluctuations due to drought and
od, to fluctuations due to variations in prices in overseas markets,
to long-term threats from powerfully organised margarine and
ificial fibre interests in more highly industrialised countries. They
nnot be relied on, therefore, on their own, to provide a firm and
ble base for the New Zealand economy. (4) While recognising
refore the need for more workers on the land, we must also recognise
need for industrial diversification which will enable all sections
the labour force to be productively employed—in other words
a relative growth of manufacturing and processing in New Zealand
the kind which can most economically be prosecuted here).
These conditions could be met only if the population as a whole
re increased. Otherwise, the development of processing and manu-
turing industries could only proceed at the expense of the rural
our force. (6) From the human point of view, a greater variety of
ice in employment opportunities, and a broader base for the
velopment of the arts and sciences in this country are much to be
ired. (7) From a world standpoint, increasing population pressures
m certain to exert much influence in the future. Whether as a result
military force or other forms of international pressure, or the

implementation of a considered judgement of a World Court at some time in the future, it may possibly be found inevitable for this country to accommodate a rather larger share of the world's increasing population.

Each one of these points suggests the advisability of preparing the way for a larger population than at present exists in this country. It is not easy to suggest reasons why a smaller population would be desirable. But to determine the exact size which could be regarded as the most advantageous is complicated by the time factor. With relative productivity per man in different sections of industry constantly changing and evolving under the influence of electrification, mechanisation, and other forms of technical evolution, it is not likely that the 'optimum' figure named on the basis of today's conditions would be valid for very long.

TABLE I

FUTURE OPTIMUM POPULATIONS OF NEW ZEALAND

YEAR	TOTAL POPULATION COMPOUNDING AT 2% P.A.
1945	1,737,000
1955	2,117,000
1905	2,581,000
1975	3,146,000
1985	3,835,000

On the other hand, it would not be possible for a rate of growth of much more than two per cent per annum to be achieved without causing disruption and unbalance in many directions. Within the limit of two per cent per annum (a figure which is based on the United States' extensive immigration experience), it seems quite possible for the national economy to assimilate the increase without recourse to emergency measures. A long period of steady and gradual growth should therefore be the aim rather than a short period of rapid growth (even if this could be achieved, which is doubtful).

We may conclude, therefore, that the 'optimum population' for New Zealand may best be regarded in the meantime as a series of populations, commencing from our present population, and increasing at something approaching two per cent per annum for a few decades at least. Were this rate of increase in fact to be achieved, the growth would be as is indicated in Table I.

To achieve this rate of increase, or something like it, we should eed both to maintain our birth rates at the highest levels reached in ne recent years of war and demobilisation, and also to admit immi-rants at a rate of something over 10,000 per annum. These are not nreasonable rates at which to aim, although they may be regarded s higher than those which we have any reason at the present time to xpect will actually happen.

Present Age Structure of the New Zealand Population

The accompanying 'population pyramid' (Fig. 2) illustrates the resent age structure of the non-Maori population in New Zealand at ne end of 1945. In examining this diagram, it should be noted that, time goes by and ages advance, the lower blocks of the pyramid vill move upwards, becoming rather shorter as they move (owing to epletion through deaths). They cannot become longer except through ne absorption of immigrants at the ages concerned. All births come in t the bottom of the pyramid. Deaths deplete all sections, though at a nuch higher proportionate rate in the higher ages.

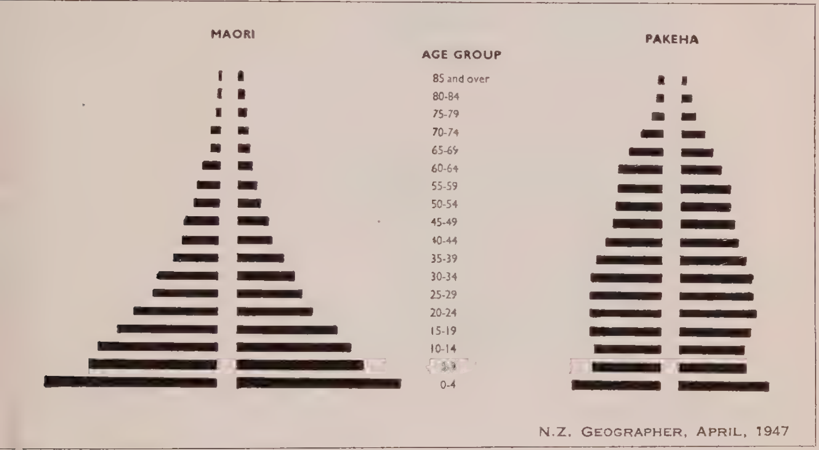

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Fig. 1. Relative Age Composition of Maori and Pakeha Populations.

It can easily be visualised how a substantial rise in the birth rate such as has occurred during the war and demobilisation period) an send a 'tidal wave' of population sweeping up the pyramid, through ne school ages, into the working and reproducing ages, and finally nto the retired class. Conversely, a sharp and sustained fall in the birth ate (as actually occurred in the depression) is absolutely certain, in

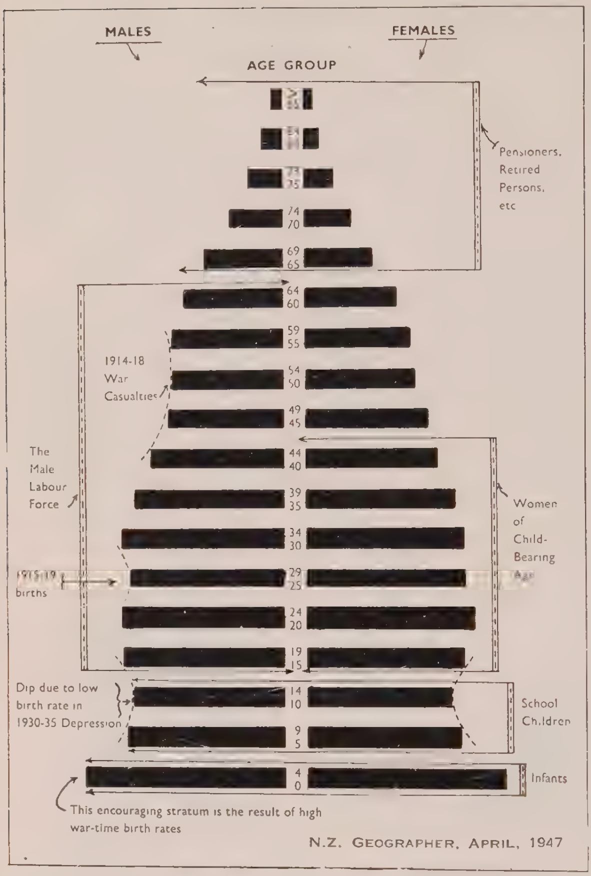

Fig. 2.
Age Composition of present Non-Maori Population.

the absence of migration, to give rise to a 'trough' moving up through the ages.

These irregularities will tend to be reproduced in the next generation by similar 'waves' or 'troughs' (though shallower and wider) moving up the pyramid about thirty years later. At the present time we are entering a ten-year period of great labour difficulties due to the shortage of young people moving up the pyramid. This shortage will be relieved only through immigration or, after another ten years, by the arrival at the working ages of the larger stratum of population to which the higher wartime birth rates have given rise.

In striking contrast to the *pakeha*, the Maori race has maintained a high and stable birth rate right through the depression and the war. The age structure of the Maoris is therefore less irregular and more heavily weighted at the youngest ages (Fig. 1). Up till the end of the last century the Maori seemed to be showing signs of dying out. Their

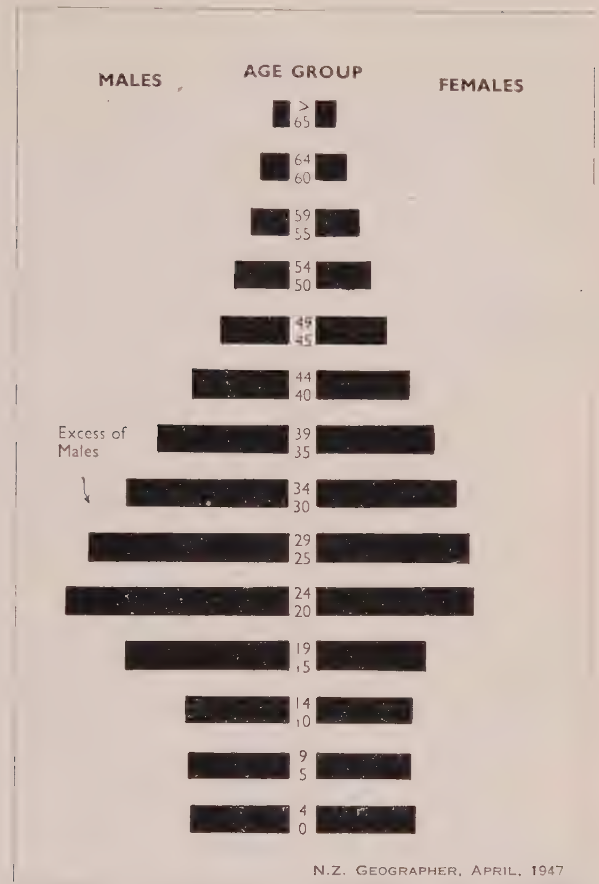

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Fig. 3.
Typical
e-Sex Composition
of
Immigrants·

mbers fell between 1858 and 1896 from 56,000 to 42,000. With
e turn of the century, however, they picked up again, and by
21 had increased slowly to over 56,000. Since that time their
crease has become more rapid and their numbers have risen as
llows: 1926, 64,000; 1936, 82,000; 1945 (end), 100,000. The some-
hat rapid increase in this century (which is rapidly gaining momen-
m) is due principally to the high birth rate. At the same time,
ath rates have been considerably higher than amongst the *pakeha*,
rticularly at the infantile ages. The Maori expectation of life as
om birth is only 46·2 years, compared with a present non-Maori
pectation of 65·5 years (males) and 68·5 years (females). Even in
te of this difference in death rates, however, the Maori race is well
the way to an extremely rapid expansion in the years to come.
Figure 3, which is based on the experience of New Zealand and
stralia after the last war, shows the age and sex composition of

what might be regarded as a normal flow of immigrants. Young adults tend to predominate, and males to outnumber females. Such a flow would tend to augment the labour force at the beginning, rather than the dependent sections of the population.

FUTURE GROWTH OF POPULATION

Taking all factors into account, it hardly seems likely that New Zealand can look forward in the future to a large and sustained flow of voluntary immigration from European sources. The fundamental reason for that is, of course, the fall in birth rates which has occurred in Europe. There will be some immigration, undoubtedly; but New Zealand's own population has now reached a sufficient size for its own birth rate to be the more decisive factor determining its future growth.

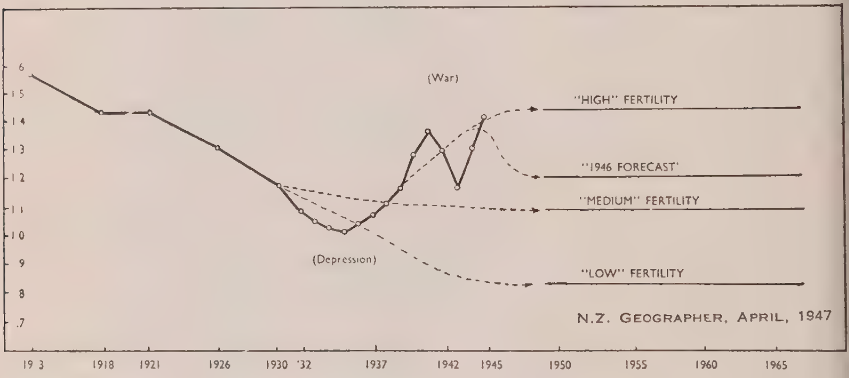

Fig. 4. Gross reproduction rates—past and projected.

We have heard much in recent years about the fall in the birth rate in this country, but how many of us realise that this fall (which had certainly been going on for sixty years) ceased and gave way to a rise a decade ago? Birth rates have been fluctuating during the war at levels which could not be regarded as unsatisfactory if they could be relied on to continue. (During the war alone, births exceeded deaths of New Zealanders by about 100,000.)

There are many and complex arguments for expecting both higher and lower birth rates than applied in the immediate prewar years, which it is not proposed to set out at length here. But it is worth mentioning especially that the principal causes of the low birth rates applying in recent years in Australia have been summarised, after much investigation, as economic insecurity, war fear, housing difficulties and lack of domestic help.

If New Zealand can maintain full employment in the future, it hould (on this argument) have high birth rates. Effective world overnment at least seems a little nearer to realisation now, though he risk of a further war cannot be said to have disappeared. The solution nder this head rests with United Nations. Housing difficulties and hortages of domestic workers will be with us for some years yet, hough both should gradually be eased through time.

Taking all factors into account, the outlook does not seem unavourable, so long as full employment is maintained. The above iagram (Fig. 4) shows the path followed by the gross reproduction rate n New Zealand from 1912 until the end of 1945, together with four ates which it has been assumed, for the purpose of illustration, might pply in the future. It has been calculated that, if we ignore further mmigration, and exclude the Maori, the remainder of the population f New Zealand would grow in the future as shown in Table II, the ate of growth being determined primarily by which of the four ssumed gross reproduction rates turns out to be most nearly correct. ach of these illustrations assumes that death rates will continue to fall n the future at each age as they have done in the past (perhaps rather an ptimistic view when applied over so long a period—but the matter s not of great importance from the point of view of overall growth). s indicated by its heading, the last column in Table II may perhaps be egarded at the present time as having the highest probability of the our. We may expect that immigration will add perhaps a further 00,000 to 600,000 to the total by the end of the period shown. As for he Maori, they will have grown, over the same sixty years, from their

TABLE II

FUTURE NON-MAORI POPULATION

(Excluding Further Immigration.)

YEAR	GROSS REPRODUCTION RATE ASSUMED			
	"High"	"Medium"	"Low"	"1946 Forecast"
1945	1,634,000	1,634,000	1,634,000	1,634,000
1965	2,023,000	1,844,000	1,711,000	1,919,000
1985	2,499,000	2,006,000	1,675,000	2,192,000
2005	3,114,000	2,121,000	1,515,000*	2,462,000

*Thereafter decreasing rapidly. Population in this column 'aging' badly toward the end of the period shown.

present 100,000 to about 500,000 if they maintain their present rate of increase.

We may see from these illustrations that, with our very low and still-falling death rates in New Zealand, we do not require to maintain birth rates at a very high level in order to show quite a substantial increase in population over a long period. We have every chance of achieving such an increase. But whatever happens, we shall have to do everything to avoid the risk of a fall in birth rates below the replacement level. An expanding community has its troubles, but it is a community with the optimism of youth and the thrill of new growth in it—a far better environment than the intense dreariness and melancholy of a community which is gradually aging and losing population.

It is perhaps necessary to point out that the New Zealand population is not yet mature. Even though continued overall growth may be in prospect for many decades, the proportion in the oldest age groups will continue to expand for many years yet. At present 8·1 per cent of the population are aged 65 and over. Within thirty years this figure will probably have grown to about eleven per cent. The faster the growth of the population as a whole, the slower will be the relative expansion of this aged section, and *vice versa*.

Geographical Distribution and Urbanisation

In the early years of the history of European occupance, New Zealand presented to traders and settlers a series of useful ports and harbours, but no internal system of communications. Towns first sprang up at these ports, and settlement proceeded inland from each one independently. The areas most favourable to immediate settlement were the plains of Nelson, Canterbury and Otago, though considerable pioneering proceeded also in the North Island. Before long the population had developed into a series of 'pockets' at points round the coast, dependent on ports such as Auckland, Gisborne, Napier, New Plymouth, Wanganui, Oamaru, Dunedin and the Bluff. Communication between these pockets depended mainly on coastwise shipping services, while the whole commerce of the separate regions flowed inward and outward through the port.

The greater ease of settlement and penetration, the discovery of gold, and freedom from troublesome Maori wars, gave the South Island at first a considerable lead over the North Island. The protection of the Southern Alps gave the settled areas an attractive climate, lthough they reduced the rainfall to some extent. Road and railway ommunications soon opened up the plains. The principal industries vere sheep rearing and arable agriculture.

With the rise of dairy farming (particularly after 1890), the North sland, with much of its forest now cleared and converted to pasture, nd with its warmer climate and more widely distributed rainfall favouring pasture growth), began to gain an advantage in attracting ettlement. Railway penetration had proceeded more slowly in the North Island, and the hilly nature of much of the country had made ettlement a slower process. With the completion of railway lines nking Auckland and Wellington with some of the earlier coastal ettlements, and of the main trunk railway, a series of inland towns prang up, notably those along the New Plymouth-Wanganui and main trunk lines.

Subsequent developments have seen a gradual decline in the relative ize of the coastal towns as coastwise shipping has decayed under competition from inland forms of transport. While Hamilton, Palmerson North, Hastings, and Ashburton have gained steadily in relation o the general population of the Dominion, thriving on an ever-ncreasing flow of inland traffic, the older ports of Wanganui, Gisborne, Timaru and Oamaru have not held their ground.

At first railway construction rigidly determined the pattern of nland settlement and the growth of towns remote from the ports. More recently the main highway and motor transport have changed he emphasis. Many of the smaller towns removed from the main orts and off the railway line have now a readier access and can be xpected to flourish. Seaside and mountain resorts, sites for weekend esidences near to the main centres, and towns such as Motueka and Opotiki have already begun to show the effects of road transport. verywhere it has blurred the sharp rigidity of the earlier pattern of ettlement, and has sent towns and cities sprawling outwards.

With the coming of air transport, the barrier of distance and the hysical separation of the North and South Islands will further diminish. s airway fares are reduced relatively to fares charged for other means f transport, resorts such as Nelson, Queenstown and Stewart Island ould benefit very markedly from this form of transport, while e main centres gain at the expense of centres which are omitted from ternal airway systems. With the aid of air and road transport the r North is now attracting a greater flow of settlement, while, on the other hand, the completion of railway links such as the South Island main trunk and the projected Paeroa-Pokeno line will inevitably have their effects.

Apart from the development of transport and communications, there have been many other influences at work. The early growth and later decline of the mining towns such as Thames, Waihi and Reefton; the moving in and moving out of sawmills with their attendant settlements (sometimes supplanted later by farming communities); the adoption of new methods of cultivation bringing closer settlement in limited areas (such as tobacco growing in Nelson); the successful implementation of irrigation schemes; the relative growth of the Maori section of the population (located mainly in the Far North and the East Cape); the growth of the proportion of older people (with consequent emphasis on population in places suitable for retirement such as Nelson, Tauranga, etc.): these have brought and are bringing permanent changes in the pattern of the population.

Superimposed on this gradually changing pattern have been the rapid formation and removal of transitory constructional camps, an occasional Exhibition or Centennial festivity, the disturbances due to war, and the regular ebb and flow of seasonal workers and holiday makers. Just as the main periods of economic depression have tended to freeze up immigration, and even lead to a temporary reversal of the long term flow, so depressions have checked the urban drift and even led to a tendency to depopulation of the main centres and return to the country. The effects of the 1930-1935 depression in temporarily checking the relative growth of the cities of Auckland and Christchurch, for example, are clearly marked in the statistical history of those years. In this review we are not so much concerned with these ephemeral disturbances as with the more persistent long term trends.

Most important of all the factors bringing permanent change has been the recent growth of the manufacturing industries, as distinct from the direct processing of meat and dairy products prior to shipment overseas. New Zealand has always done a certain amount of local manufacturing. Bricks, sawn timber, wooden furniture, and blacksmithing services, for example, have always been attended to here. The real emphasis has come, however, with the more recent expansion of the textile, clothing, knitwear, hosiery and footwear industries, the engineering and motor assembly group; the manufacture of confectionery and finely-processed foods and processed tobacco; building terials such as paint, wallboards, fittings; printing and stationery; ss products, concrete products, fertilisers, rubber goods, radios, drugs d cosmetics.

The earliest forms of manufacture were mainly 'rooted' and 'local' the true sense of the word. Freezing works were located near to the ck raising areas. Butter and cheese factories were scattered through dairying areas. Bakeries, brick kilns, blacksmiths' establishments, d furniture factories were to be found in every one of the early ckets of population and served their local markets. Industries more cently established, on the other hand, have often been of the 'foot-ose' kind. The whole of the Dominion's motor assembly work is ncentrated in the Hutt Valley; clothing and footwear manufacture hich might well have been decentralised) is concentrated almost clusively in the four main centres, some sixty per cent being in ckland; one glassworks serves the Dominion; there are only three ment works; radios, rubber goods and batteries are made practically clusively in three main centres. Industry has grown upon industry. here basic manufacture is found, there are workers, and hence keries, postal and transport services, banks, shops, hairdressers, enter-nments, ice cream factories, schools and churches. All these—and ers—follow in a long procession.

Once centralisation becomes the rule there are many influences rking to increase its momentum. Not only do basic industries attract uperstructure of servicing industries, but, by drawing population, ctric power, and transport links, often attract other basic industries the same vicinity. In the absence of deliberate measures to guide w factories to the intermediate centres, the tendency will always be them to congregate more and more in the principal centres. Such s been the experience of many countries.

Validity of Trends in Forecasting

In attempting to visualize the *future* pattern of population growth New Zealand, it has been thought advisable to assume a continuation most of the trends which have been observed to apply in the last rty years. The growth of the Maori section of the population, the d and retired section, the manufacturing industries relative to the ming industries, and the larger centres relative to the population a whole, are trends of so fundamental a character that practically thing could happen to alter them. The relative growth of the strategically placed inland centres of Hamilton and Palmerston North as compared with smaller and less strategically placed centres such as Feilding, Dannevirke, or Hawera, is a virtual certainty.

The superior hydroelectric power resources of the South Island, and the potentialities there for closer settlement based on irrigation, as well as the existence of conditions favourable to manufacture and to the exploitation of minerals and tourist attractions, may combine over a period to check the relative swing to the North Island. For present purposes it has been assumed that during the next thirty years the South Island population will not gain relatively to the North Island, but will continue to lose, though at a somewhat diminishing rate. At the same time, there is every reason to expect an increase over this period in the absolute size of the South Island population itself.

Other factors to be considered include the likely progressive establishment of sawmills and factories based on the pine forests in the Rotorua-Whakatane-Taupo area, the development of the tourist industry, and the likely effects of a Government policy aimed at the decentralisation of new factories in suitable and obvious cases. The progressive increase in the development of administrative services, often organised on the lines of a Head Office in Wellington and some twenty-five or so district offices located in the 'pivotal towns' or 'regional centres' of Whangarei, Auckland, Hamilton . . . and so on south as far as Dunedin and Invercargill, has already set in motion a tendency to reinforce this group of regional centres at the expense of the smaller centres in their vicinity. This is a factor which can probably be assumed to continue over the long period.

Unknown factors, which cannot be brought into account at this stage include the possible industrial application of atomic energy and similar scientific discoveries (which may reduce in some ways the dependence on coal and hydroelectric power resources); the possible adoption of a particularly rigorous policy of decentralisation; and the possible impact of international policies prejudicial to the Dominion's manufacturing industries as a whole.

The relative growth of commerce, education, hospitals, entertainments, professional services and other tertiary industries and employments, which thrive on and add to the mere agglomeration of population, will in any case strongly reinforce the trend toward continued urbanisation and centralisation, regardless of other factors. The principal factors which seem likely to lead to an absolute if not a lative increase in the numbers of New Zealand's rural population e: the long-term trend toward types of farming (such as dairying, ticulture, tobacco growing, market gardening, etc.) which bring oser settlement; the increase in Maori population (most of which engaged in rural occupations); the higher birth rates and lower eath rates applying in the country; and the differential effects of the ew family benefit in raising rural birth rates still further above city rth rates (the cost of rearing a child being less in the country). perating against these factors will be the continued gravitation wards the centres of population as described above.

TABLE III

Forecast of New Zealand Population Growth

	1916	%	1945	%	1975	%
otal for Dominion (including Maoris and troops overseas)	1,112,200		1,746,300		2,505,600	
otal in North Island ..	725,600	60·86	1,174,700	67·28	1,730,300	69·05
South Island ..	466,600	39·14	571,600	32·72	775,300	30·95
etropolitan area of:—						
Auckland	139,900	11·73	270,400	15·48	441,800	17·63
Wellington	99,600	8·36	177,500	10·17	283,100	11·30
Christchurch ..	96,500	8·09	155,700	8·91	249,700	9·97
Dunedin	71,500	6·00	86,400	4·95	112,800	4·50
ur Main Centres	407,500	34·18	690,000	39·51	1,087,400	43·40
wenty-nine Secondary Centres	211,000	17·69	337,600	19·33	526,200	21·00
emaining Small Towns ..	115,400	9·68	151,700	8·68	203,000	8·10
ural Population	458,300	38·45	567,000	32·48	689,000	27·50

The table above (Table III) shows how the population of the ominion has grown, and how it may perhaps be expected to grow, each island, in each of the main centres, and in some parts of the ominion. The relative shifts which have occurred from the South land to the North Island, and from country to city, are shown clearly the two columns relating to the past. The figures for 1975 indicate the ape into which the population seems at present to be drifting.

Had we concerned ourselves with regional structure rather than ith urban structure we would have noticed a tendency to aging and ven depopulation in the rural parts of Otago, South Canterbury, uller, Wairarapa and Thames, and at the other extreme a healthy verall growth in the North Auckland, Waikato, Rotorua-Taupo and

Bay of Plenty areas, other areas falling into an intermediate position with only slight changes in the rural populations, nearly all of the growth being usually at the main centre of the region.

New Zealand's population is drifting citywards, but not nearly so quickly as did that of some other countries. It has taken thirty years for the rural population of this country to fall from 38.5 per cent to 32.5 per cent of the total. In the first thirty years of this century the rural population of the United States of America fell from 52 per cent to 36 per cent.

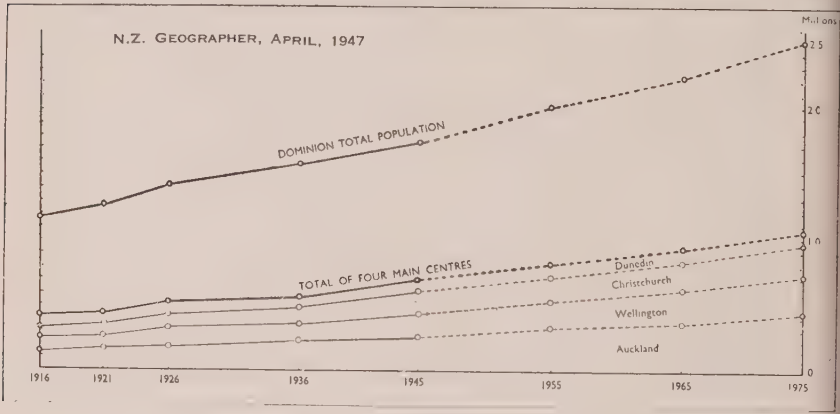

Fig. 5. Trend towards Centralisation in New Zealand.

Nevertheless the tendency to centralise is clearly operating, and (what is more important but lesss widely known) this trend is accelerating. If New Zealand is to avoid the development in the long run of huge centres of population at Auckland, Wellington and Christchurch, while the provincial centres and small towns decline and stagnate, then vigorous administrative measures will be necessary.

It was pointed out above how the establishment of a 'basic' industry draws other industries and services to the same locality, the flow of population following the establishment of the 'basic' industries. Certain industries cannot be shifted. If established at all, they must be located at a particular spot, where raw materials, etc. are already located or (as in the case of many heavy industries) near to ports. But there are many cases where an arbitrary decision can be made as to where a factory is to be placed. (Take a hosiery mill, for example.) Such cases are known as 'foot-loose' industries. It is they which provide the key to the problem of how to steer the flow of population. There will be no need to steer the flow of new shops, new houses, new schools, etc.

these industries are steered into the right localities. Like so many comotives, each of these industries will in time bring along after it a nole train of shops, post offices, residential quarters, churches, and all e other outward expressions of population growth.

Up to the present there has been no control over the population ift. To bring this drift under some kind of control is not a matter to be dertaken lightly. Perhaps it is best, some say, to let the 'unseen rces' have their way, and to avoid imposing any limitation on the erty of the people to go where they please. This appealing argument ould be unanswerable if it were not so apparent that, in the absence of ntrol, we are headed for fairly rapid centralisation, and if it were t the universal opinion that too much centralisation is a bad thing for y country.

The position under *laissez faire* is that very few people do go where ey please, anyway. Most go where their jobs take them. They go nere there are openings or where there is the best market for their vices. As New Zealand gradually becomes more industrialised, the ople will go more and more to the places where manufacturers decide put their factories. Not many manufacturers concern themselves th the social consequences of locating their plants in pleasant or pleasant towns, in large cities or provincial centres. But it is their cisions which will in the future more and more determine the shape New Zealand's population pattern, and all that goes with it. Perhaps would add to the liberty of the people rather than subtract from it hese key decisions were subject to some kind of check by or agreent with an authority representing the interests of the people and ncerning itself with the shape of the population pattern and with its ation to the welfare of the community as a whole.

It is an odd thought that New Zealand is adding to her urban ital at the rate of something over £30,000,000 each year, but for ny decades no one seems to have been very concerned as to where growth has been taking place, or whether it is leading to further balance between housing and factories, population and employment. w Zealand is pledged to full employment, but no forces have been ering the location of factories or other places of employment to the as where surplus labour already exists. It is often in the smaller vns rather than the main centres where manufacturers seem to sist in congregating regardless of labour shortages and housing iculties.

Only in the last year has an *ad hoc* committee been established t deal with this vital question. Its report made, the committee disbanded Administrative machinery, adequate to handle the question, has (at th time of writing) still to be set in motion. Should such machinery dul become established, may its operation be tempered alike with a dee insight into the sociological side of human affairs and into the need and problems of manufacturers. And may it be guided ever by a clos and detailed knowledge of the resources and geography of Ne Zealand.

LAKE COLERIDGE CATCHMENT: A GEOGRAPHIC SURVEY OF ITS PROBLEMS[1]

W. P. PACKARD

OME SIXTY MILES west of Christchurch lies the Lake Coleridge
hydroelectric power station, second producer of power in the
uth Island. Waitaki, the largest single unit, generates half of the
uth Island total; Lake Coleridge, a fifth. The Waitaki scheme is
pendent however, upon a snow-fed river having a natural decrease
water supply, and consequently in power production, at the season
greatest demand. Lake Coleridge station, with its effective natural
servoir, the lake, suffers no such decline in winter water supply.
periods of breakdown or abnormal demand, it is Lake Coleridge
hich must be prepared to generate the power deficit. In order to
rry out this unique function of both constant and emergency produc-
on, Lake Coleridge must be assured at all times of an adequate flow
water from the Harper River which, with its tributary, the Avoca,
s been diverted into the lake since 1924. These two rivers supply
er nine-tenths of the water of the hydroelectric plant; yet despite
eir importance to the hydroelectric system, little was known until
e present investigation was undertaken about their position and
butaries, let alone the surface cover of their respective drainage
sins. Wide fluctuations in water supply and apparently increasing
od levels had led the hydroelectric authorities at Lake Coleridge to
spect that the water supply to the lake might be endangered by
pletion of surface cover, and this investigation has been the result
gely of their and the North Canterbury Catchment Board's anxiety.
survey of surface cover was made, using the fractional notation unit
ea method described by Robinson,[2] considerable base map correction
ing necessary in the upper portion of the Catchment.

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is article is a condensation of a report furnished by the author to the North Canterbury
tchment Board under whose auspices the original investigation was conducted. It is published
re through the courtesy of the Board.—*Edit. note.*

W. Robinson: *A Method of Land Classification for New Zealand*; Unpublished University of
w Zealand Thesis 1945. See also the *New Zealand Geographer*, Vol. 2, No. 1, 1946, pp. 253–259,
d K. B. Cumberland, 'The Survey and Classification of Land in New Zealand: A Basis for
nning', *Trans. & Proc. Royal Soc. N.Z.*, Vol. 74, No. 2, 1944, pp. 185–195.

THE NATURAL CONDITION OF THE CATCHMENT

Broad simplicity of structure and of relief characterise the Lake Coleridge catchment area. A few isolated pockets of down-faulted, weak, gently sloping (30 per cent) Tertiary sands and clays, most notably in the mid-Harper valley, provide a small but significant contrast in surface form to the steeply sloping (60-70 per cent) resistant greywacke which covers two-thirds of the area of the catchment. Two lines of faults, viz., ENE-WSW and NNW-SSE roughly at right angles, guided the main river valleys and chains of lakes, and were probably responsible for the direction of the glacial hollow now occupied by Lake Coleridge. A severe earthquake in June 1946 affirmed the present 'mobility' of this fault-crossed area; shatter zones marked by well developed bedrock gullies tell of former large-scale movements. Enormous Quaternary glaciers filled the fault-guided valleys, changing their shape, steepening slopes, truncating spurs, levelling valley bottoms, and spreading thick morainic deposits over the lower courses of the streams. The last phase in the formation of the present relief was the levelling of these irregular deposits by the flood waters consequent upon the enormous ice melt as the glaciers retreated. Faulting and glaciation explain therefore, the remarkable surface forms and the parallel valleys of the region.

CLIMATE

Paucity of weather records severely limits any study of the climate of alpine Canterbury. Only the occasional homestead records even the daily rainfall, and in Lake Coleridge catchment, only the power house collects such other essential climatic data as that referring to temperature, humidity and cloud. While it is a matter of common knowledge among those who live in the back country that the rivers flood with nor'west rains (especially in the spring), that much of the rain falls in intense local downpours with periods of bright sunny weather interspersed, that ground frosts are of almost nightly frequency in the higher parts, that the two sides of a valley may have quite different climates, and that winds are frequent, strong and desiccating, there are no records to give statistical support to these broad generalisations. Until there are such recording instruments as automatic rain gauges and thermohygrographs located in strategic positions throughout the district, no really accurate description of the climate, nor of the river regimen will be possible.

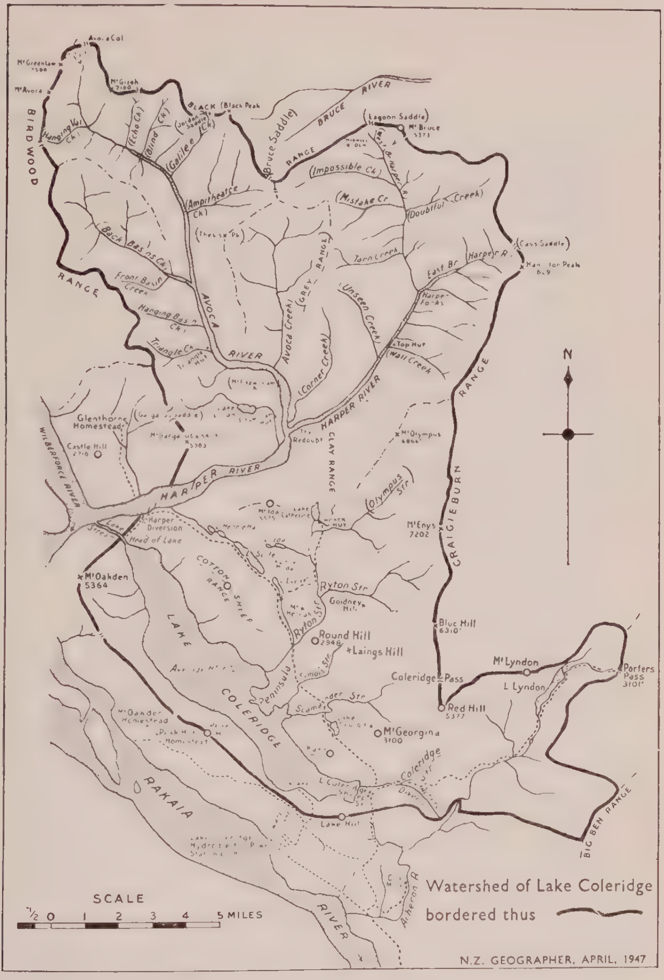


Fig. 1.
ke Coleridge
Catchment.
ocality Map.
ature names in
ckets are sub-
to confirma-
by New Zea-
d Geographic
Board.)

It is apparent that rainfall increases up-valley as the Main Divide is proached. Lake Coleridge Power House has an average annual nfall of 32·5 inches. Harper Diversion, 11 miles closer to the Main vide, has 47 inches; and Glenthorne, only 3 miles up the Wilberforce m Harper Diversion has an average of 59 inches annually. Nor'west ns apparently predominate in the upper valleys, but at the power tion they are infrequent. Heavy showers, with an absence of drizzly eather, are usual; local downpours not uncommon. However, there no accurate measure of their actual frequency and severity. The daily enty-four hour totals reveal large amounts of precipitation per day: 96 inches at the power house, and 4·07 inches at Harper Diversion the greatest twenty-four hour totals recorded, but are a poor

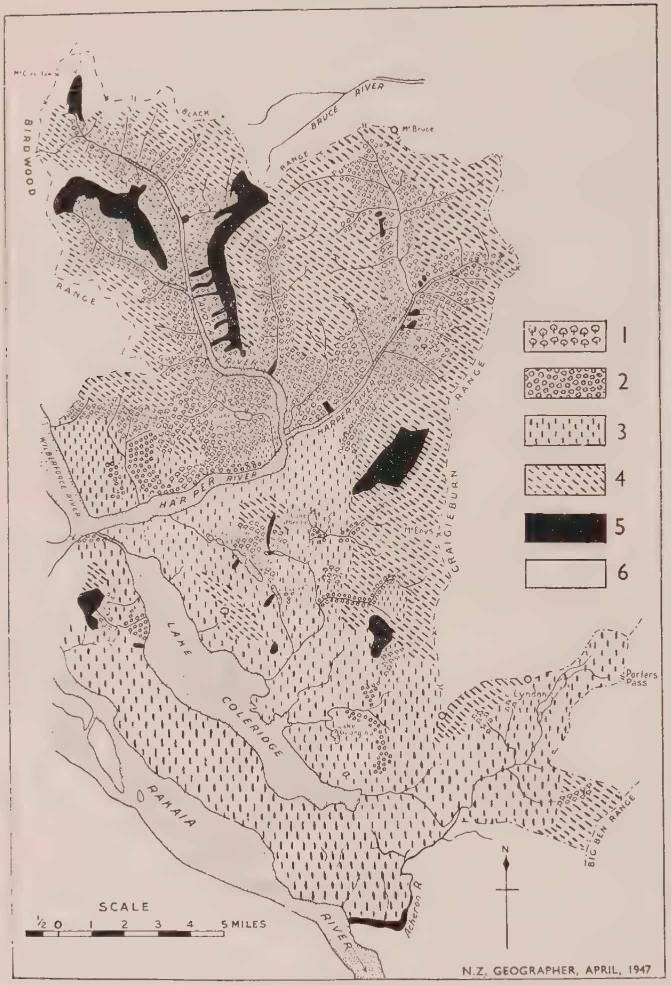
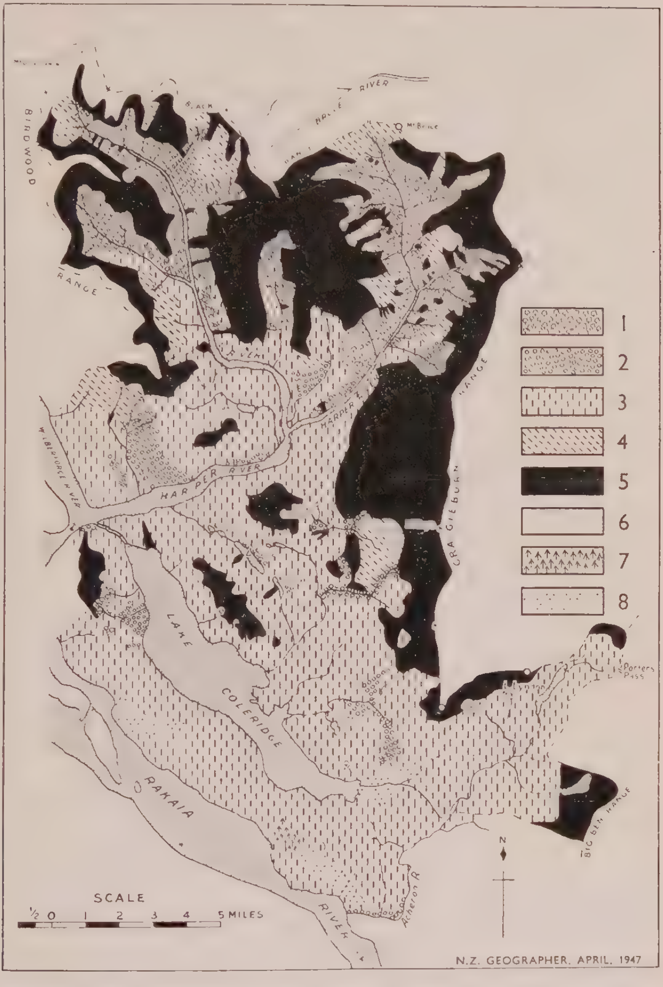


Fig. 2.
Lake Coleridge
Catchment.
Natural
Surface Cover.

1. Beech forest.
2. Scrub.
3. Tussock.
4. Subalpine vegetation.
5. Shingle and rock.
6. Bare rock, ice and snow.

measure of real intensity. Long rainless periods do occur: the Harpe Diversion has experienced a month and a half in summer without an rain. Open tank evaporation figures reveal that almost eighty-fou per cent of the water so exposed is evaporated during the year; under vegetation cover it must be less, though to what degree, is quit unmeasured. Microthermal variations are similarly obscure and worth of detailed investigation.

Wind direction is conditioned by relief, nor'westers being mos frequent, and the high, steep-walled nature of the valleys increases thei force. It is the warm nor'west rains in spring, releasing the accumulate winter precipitation of snow, that are responsible for the floods characteristic of Canterbury rivers at that season. The slowing down of thi spring run-off by an absorbent vegetation covering is essential if



N.Z. GEOPGRAPHER, APRIL, 1947

Fig. 3.
ake Coleridge
Catchment.
Present
Surface Cover.
Beech forest.
Scrub.
Tussock.
Subalpine
vegetation.
Shingle and
rock.
Bare rock, ice
and snow.
Plantation.
English grass-
land.

eady water supply is to be maintained. Even though the Harper rises ith southerly rains (which do not penetrate up the Avoca), and thus elps to maintain a more even seasonal flow than is normal to most anterbury back country rivers, and even though the Avoca, being acier fed, has a small but dependable winter and summer flow, the owing down of this spring run-off is essential. Before one can plan maintain adequately the flow of the Harper and Avoca, the various ysiographic, vegetative and climatic factors responsible for their gime must be understood. The climatic factor cannot be evaluated ntil many day by day records of weather are collected.

Soils and Primitive Vegetation

One all important fact stands out from a field examination of the ils of Lake Coleridge catchment. Immaturity of soil, whether of the

Tasman, Omarama or Kaikoura series, is almost universal.[3] Lack of profile development gives a clear indication of the skeletal nature of the soil. A stony subsoil is general throughout the region. In some places it is covered by a thick mantle of glacial clay. Slopes are steep; the parent rock is hard; geological erosion is active, and the soils are naturally thin. Profiles of a depth greater than 12 inches are infrequent. Local variations in rock type and in vegetation cover are reflected in local soil variations. Everywhere however, soils are marked by the characteristics associated with immaturity.

TABLE I

SUMMARY OF AREAS ON FIGURES 2, 3, 7, AND 8.*

Figure 2 NATURAL SURFACE COVER			Figure 3 PRESENT SURFACE COVER		
	% total area	acres		% total area	Acres
Beech Forest ..	20·2	31,800	Beech Forest ..	11·1	17,600
Scrub	1·7	2,760	Scrub	2·2	3,200
Tussock Grassland ..	42·7	67,600	Tussock Grassland	46·0	72,400
Subalpine Vegetation	28·9	45,700	Subalpine Vegetation	5·7	9,700
Shingle and Rock ..	4·4	6,920	Shingle and Rock	31·2	49,140
Rock, Ice and Snow	2·1	3,400	Rock, Ice and Snow	2·1	3,400
			Plantation	·2	310
			English Grassland	1·5	2,430
	100·0	158,180		100·0	158,180

Figure 7 CONDITION OF PRESENT SURFACE COVER			Figure 8 SOIL EROSION		
	% total area	acres		% total area	Acres
Excellent	3·0	4,740	Little or none ..	5·7	9,750
Good	13·5	21,100	Some—not serious	13·8	21,750
Fair	26·7	42,300	Obvious	29·9	47,000
Poor	38·1	60,340	Considerable ..	36·6	57,580
Very Poor ..	16·6	26,300	Excessive ..	11·9	18,700
Rock, Ice and Snow	2·1	3,400	Rock, Ice and Snow	2·1	3,400
	100·0	158,180		100·0	158,180

*These data are the result of planimetric measurements of the different maps, and because of the arbitrary nature of the boundary lines, should be taken as broadly indicative rather than areally exact.

Only Samuel Butler and his companion saw the Harper-Avoca area before the first fire, lit by them on March 3 1860, burned out much of the primitive plant cover.[4] Modification had taken place, therefore, ng before any detailed description of the tussock grasslands of the uth Island was made, and in the Lake Coleridge catchment no tailed investigation has been carried out. The map of natural plant ver is the result of a study of the present-day vegetation, especially lated remnants, and of the meagre descriptions of early writers.

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[3] These are the type names of the three soils shown on the map of the South Island high country in the recent D.S.I.R. Bulletin as occurring in the Lake Coleridge area. See H. Gibbs and J. Raeside: 'Soil Erosion in the High Country of the South Island', *N.Z. Dept. Sci. Industr. Res. Bull.*, No. 92, 1945.

[4] Samuel Butler: *A First Year in Canterbury Settlement*, London, 1914.

A dense, dun-coloured fescue tussock (*Festuca novae zelandiae*) sociation ('low tussock grassland') covered much of the lower untry, with isolated areas of red tussock (*Danthonia raoulii*) association all tussock grassland') on the damp shady faces with 'sour' soils or the casional swampy lowland. Low tussock grassland was composed of nchy, close-set tussocks around whose base a mat of decaying getation remained ever moist and beneath whose sheltering, needle-in leaves, delicate intertussock plants such as aniseed (*Angelica mon-a*) flourished in their moist and cool microclimate even when ssiccating nor'west gales raged two feet above. It was the ideal plant ver to retain soil moisture and to bind the surface in so dry an area. om the few remnants of blue grass (*Agropyron scabrum*), plume grass *ichelachne crinita*), blue tussock (*Poa colensoi*), and tall blue tussock *oa intermedia*) (all much more palatable and nutritious than the mmon fescue) found scattered in isolated areas, it can be assumed at they were common in the primitive grassland. Butler makes cial mention of the matagouri thickets in the Avoca, impenetrable horse or man, and of the hostile spaniard (*Aciphylla spp.*).

Subalpine vegetation, clothing the slopes above 4000 feet, was minated by snowgrass (*Danthonia flavescens*). Similar to its lowland ative, red tussock, and normally as much as or more than three t in height, snowgrass frequently spread over twenty square feet, ording complete protection to the skeletal soil. Scattered plants such snowberries (*Gaultheria spp.*), spaniards, and mountain daisies (*Cel-sia spp.*) were present where individual tussocks were not close, me light reaching the otherwise permanently darkened surface. the large areas of shingle and bare rock grew plants adapted to se most exacting environments. Patches of whipcord hebes (*Hebe* .), raoulias (*Raoulia spp.*) and allied plants were dotted here and re, helping to stabilise the shingle, adding some humus to the rock terial, and forming the beginnings of a soil. Essential to the estab-ment of a plant cover, their loss has been a serious one.

A dark green belt of mountain beech forest (*Nothofagus cliffortioides*) ntled the sides of the Harper and Avoca Rivers from their junction to their heads. Early observers such as Haast,[5] described the Avoca valley as 'clothed in dense forest . . . . growing luxuriantly'. Beyond general statements they did not go, and it is impossible to form an accurate picture of the natural beech forest from the records available. This is especially so since the rainfall, a factor shown by Cockayne[6] to have a major effect on the character of a mountain beech forest and its floor, is a matter of conjecture for the greater part of the catchment. From patches of beech forest with the definitely 'wet' characteristics such as lichens, mosses, liverworts and fungi, rotting damp trunks and *Coprosma* undergrowth, it has been assumed that such conditions were natural to the larger part of the primitive beech forest.

It can be seen therefore that any picture of the natural conditions of the Lake Coleridge catchment must be largely a matter of assumption because of the inadequacy of the records. It is evident that the primitive plant associations must have been profoundly modified, but until detailed ecological studies of such plant associations as dry *Nothofagus cliffortioides* forest are made, the extent and exact nature of that modification must remain unknown. It may be deduced however, that in pre-European times the surface of Lake Coleridge catchment was well clothed. No grazing animals disturbed the surface cover. Plants lived and died undisturbed and added their share of decaying matter to the slowly building soil. The infrequent earthquakes brought slips and gullies which for the most part healed rapidly, as did the scars torn by avalanches in the beech and subalpine belts. The process of geological erosion was kept at a minimum. A state of readily adjustable balance existed.

PRESENT CONDITIONS: TUSSOCK GRASSLAND

Superficially the low tussock grasslands of the Lake Coleridge catchment appear to remain unmodified by European occupance. Low bunch-forming fescue tussocks are still dominant plants. But on a closer examination changes in the composition of the grassland are apparent. The delicate, nutritious intertussock species, known to have been present in quantity in the original association, the highly palatable aniseed and edible grasses such as blue grass (*Agropyron scabrum*) and holygrass (*Hierochloe redolens*) are rarely found today. Several 'new' plants are present. Almost universal and especially prominent on dry

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[5] Julius von Haast: *Report on the Headwaters of the River Rakaia*, 1867.

[6] L. Cockayne: 'Monograph on the New Zealand Beech Forests, Part I', *New Zealand State Forest Service Bulletin No.* 4, 1926.

4. Burning and graz-
have opened up the
se primitive tussock
er at the head of this
n just south of Mt.
iden and depletive
es have removed the
and initiated gullies
shingle slides. Detri-
is rapidly burying
ocks, matagouri, and
bage trees on what was
merly a tussock-
covered fan.

Photo: G. J. Currie.

. This 'flat' (two per-
t slope) was once
ered with beech forest
the induced tussock
been weakened by fire
overgrazing so that it
unable to withstand
d-stripping, frost
ve, and sheet erosion.

6. An eight-feet high
of *Danthonia setifolia*
cates the tremendous
unt of soil which has
removed from this
r-shaped hollow in

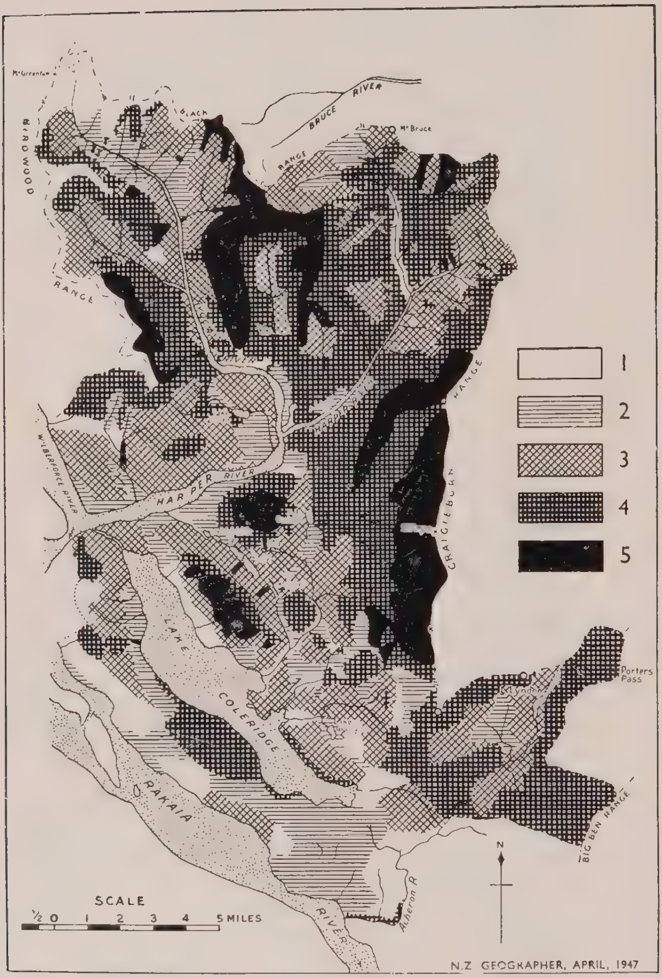
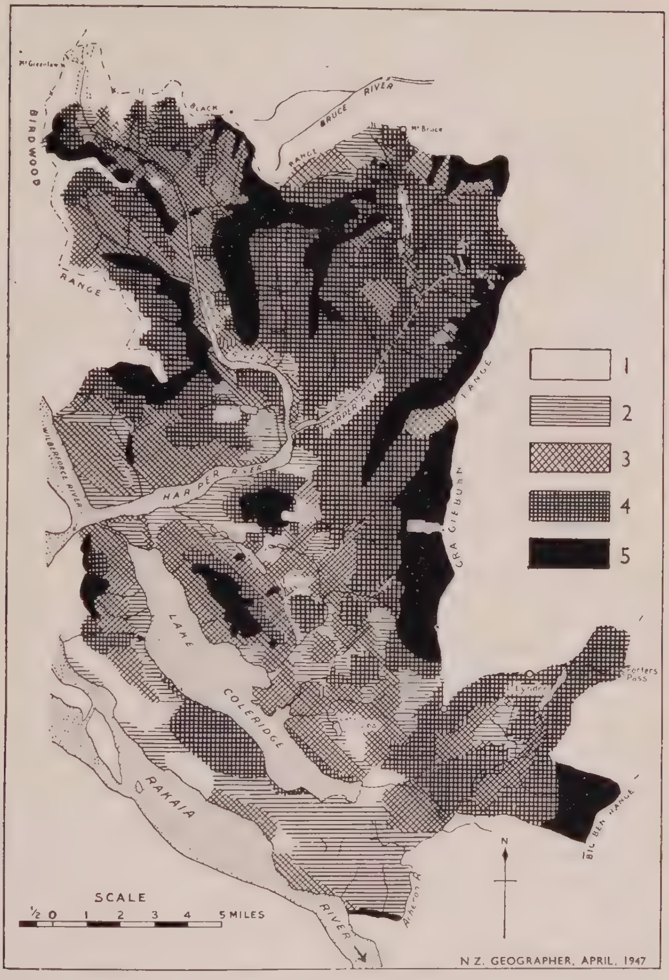


Fig. 7.
Lake Coleridge
Catchment.
Present
Surface Cover.
1. Excellent.
2. Good.
3. Fair.
4. Poor.
5. Very poor.

sunny faces is catsear (*Hypochoeris radicata*). A despised weed in 'down country' pastures, catsear is possibly the most important edible plant in the tussock grasslands of Lake Coleridge. Three introduced low production grasses take a prominent part in the plant association today, Yorkshire fog (*Holcus lanatus*), sweet vernal (*Anthoxanthum odoratum*), and to a lesser extent, browntop (*Agrostis tenuis*). Yorkshire fog is found on all shady tussock faces, while sweet vernal is common on the drier soils of river flats and sunny faces. In the early days of European settlement clovers and other English grasses were surface sown on the easier portions of the runs. The higher production species generally failed to persist, but fairly dense white clover (*Trifolium repens*) swards



N Z. GEOGRAPHER, APRIL, 1947

Fig. 8.
ake Coleridge
Catchment.
Soil Erosion.
Little or none.
Some, not
serious.
Obvious.
Considerable.
Excessive.

still found on the isolated flats of the upper Avoca parkees[7] and in ited areas elsewhere where a close tussock cover gives shelter from parching nor'west winds. A native plant not present in quantity in natural grassland, but now very widely distributed, is patotara, or arf heath (*Leucopogon fraseri*). This low-statured shrub with sharp ves and small orange berries is a hardy, light-loving weed, inedible sheep, and not exacting in its fertility requirements. It occurs quently among the stunted tussocks of overburned and overgrazed es. Five virulent weeds are present in sufficient quantity to make m potentially dangerous, even though they are not so today. Sweet

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kee: a tussock flat more or less surrounded by beech forest.

briar (*Rosa eglanteria*) favoured by the deer, is flourishing near Fitzwilliam hut, and is spreading thence up the Harper and Avoca Rivers. Foxglove (*Digitalis purpurea*) is found on shingly soil where beech forest has been burnt and replaced by a fescue tussock cover. Bracken fern (*Pteridium esculentum*) is common where the surface cover is thinning as a result of burning and heavy grazing. The yellow-flowering, drought-resistant annual, St. John's wort (*Hypericum perforatum*), is found on the drier southerly parts of the tussock grassland from the Peninsula where it forms almost pure associations to the easterly flanks of Mt. Ida. Gorse (*Ulex europaeus*) is becoming predominant in a few restricted localities, notably by Monck's hut. Repeated burning appears to have encouraged, rather than checked its growth.

On some frequently burnt shady faces two inedible native weeds, Maori onion or bog lily (*Chrysobactron hookeri*) and the cotton plant (*Celmisia spectabilis*) assume local dominance. Two other native plants, spaniard (*Aciphylla spp.*) and 'old man' matagouri (*Discaria toumatou*) have now disappeared. It was often to destroy these two tall spiny shrubs that the early runholder so freely put his match to the tussock grassland. Juvenile matagouri up to 4 to 6 inches in height is the runholder's most commonly thought-of weed, but it is doubtful if fire can conquer this hardy shrub. Indeed the reaction of matagouri to fire is a matter of considerable importance and worthy of detailed investigation.

Burning and Grazing

The two fundamental reasons for the present condition of the tussock grasslands are the burning and overgrazing of the plant cover.[8] These factors underlie the problems of soil erosion, vegetation depletion and weed invasion. Discussion with the local runholders reveals that while they are very much aware of the dangers of burning the tussock cover, they unwillingly employ fire as the only economic means they have of suppressing dense scrubby growth that hinders mustering. Lake Coleridge station has the additional problem of chance fires lit by careless 'down-country men' who may travel on the public roads through the property. However, the destructive effect of present day burns is but slight compared with the widespread conflagrations of earlier days. The first recorded fire was lit by Samuel Butler in the Avoca valley in

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[8] See K. B. Cumberland: 'Burning Tussock Grassland: A Geographic Survey', *New Zealand Geographer*, Vol. 1, No. 2, October, 1945, pp. 149–164.

60.[9] Many others followed. The early fires soon destroyed the red sock on swampy areas, the spongy litter of surface humus which s the accumulation of ages, and the weak intertussock plants. ey created fresh edible growth of green tussock, but also weakened d breached the surface cover, and helped the weed invasion of e-resistant plants. Fire-weakened tussocks were grazed too soon after rning, thus checking reseeding. From the viewpoint of even short-m conservation the runs have been overstocked. Sheep have conntrated on burnt patches and on sweeter sunny faces rather than ze amongst the unfired tussock or on the less attractive shady faces. bbits, deer, and hares have played a further part in the depletion an already degenerate plant cover. The change after the Great War m pure merino flocks to mixed flocks of half breds and merinos es not seem greatly to have alleviated the pressure of grazing. ough the half-bred sheep spare the 'tops', their concentration on ver slopes may mean that winter country is eaten out during the mmer. If the half bred is to replace the merino completely, thus ing the remnants of high altitude vegetation a chance of survival d if the lower country is not to degenerate further, the total number sheep carried on the four stations will have to be reduced.

SOIL DEPLETION

Apart from a few level or undulating areas which are well covered h English grasses, and extensively grazed and manured, the conion of the surface cover in the tussock grasslands is only 'fair'. On ny slopes accelerated soil removal has been taking place.[10] Gullying d shingle deposition are the most spectacular forms of soil erosion the catchment, but no less dangerous are the insidious and often ppreciated forms of soil depletion: sheet wash, frost heave, and nd erosion. These latter, acting on the bare patches in fire-weakened, rgrazed grassland, bring soil wastage to the point where gullying d talus formation are inevitable. Wind stripping, frost heave, and et wash are persistently allied in accelerated soil removal. Frost on, combined with sheet wash and wind stripping, plays a pronent role in the higher parts of the grassland where ground frosts y occur over 200 nights a year and subsoil ice crystals are not ommon during the summer. Frost heave pulverises the soil, lifts up

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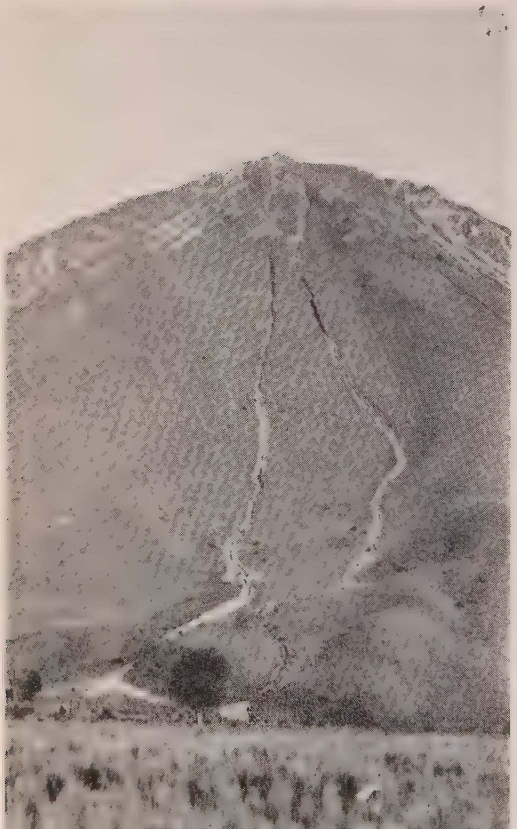
Butler: *ibid* pp. 52–58.

also Gibbs and Raeside *loc. cit.* and K. B. Cumberland: *Soil Erosion in New Zealand: A ographic Reconnaissance*, 2nd edit. 1947.

plants newly established on bare surfaces, and provides the agents of water and wind erosion with finely divided, deeply loosened surface material. During a windy spell 'dust devils' are often seen spiralling off slopes apparently well clad with vegetation. The climax of wind stripping and frost action is seen in an area close to the road near Simois and Scamander Streams. A small local man-made 'desert' has been produced, and as a measure of the decline in soil fertility, scabweed, the first colonizer of river-bed shingle, is the only plant found on this bare stone-littered surface.

Talus and gully erosion are the climax forms of soil depletion found in the tussock grasslands of the district. Surface shingle is seen all too frequently; it is nearly always on the move, burying tussock and other growth. Stable shingle (shingle slides marked by ingrowing edges of tussock, bracken fern or matagouri) is infrequent. Where beech forest has been burned in the lower Avoca River and tussock grassland induced, topsoil has been removed and the shingly subsoil, formerly anchored by tree roots, now appears at the surface. The faces of Triangle Creek,[11] once closely clad with beech, were burned at the turn of the century, and a cover of fescue tussock induced. The tussock has been unable to anchor the soil as effectively as the forest and following recent disintegration of the beech roots, soil removal and shingle accumulation has accelerated. Today the flanks of Triangle Creek are covered by almost coalescing talus slides.

Fig. 9. From Fitzwilliam Hut one sees these two striking initial gullies. A good stand of fescue tussock is found on the river terrace in the foreground.



Gullies are the most impressive forms of soil erosion in the tussock grass-

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[11] Name subject to confirmation by New Zealand Geographic Board.

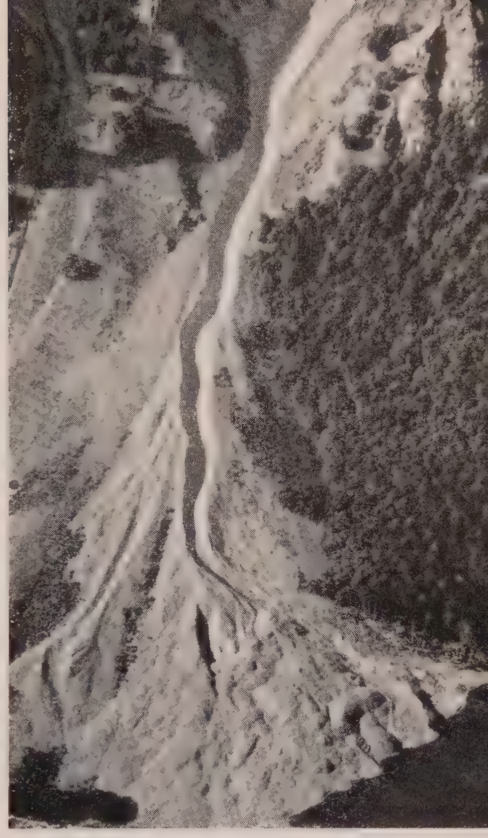

Fig. 10. Serious deterioration of surface cover is illustrated by this gully and fan debouching into Lake Ida. Devegetated upper slopes during a local 'cloud burst' spewed forth a cone of shingle over the old fan and bisected the lake.

nd area. All stages of evelopment are present in ne catchment, from the allow V-shaped gutters a oot or so deep eating into nooth tussock slopes, to ulches of the size illustrated the photographs here. he heads of most gullies re located directly below ock outcrops, and it ppears that under a stable lant cover, precipitation lling on the rock outcrop vould soak into the well-nchored subsoil beneath ne bluffs. When the tussock as been depleted, such vater does not percolate ently, but runs off rapidly: couring takes place, and a ully is initiated. The tense rainfall enlarges the ullies and depths of ten r more feet are common. Many gullies, initiated in the subalpine one, have cut channels into the tussock grassland, or debouch as shingle ns, covering the tussock with a thick mantle of greywacke detritus. uch a gully occurs on the shady face of Mt. Ida. An isolated belt of eech forest which clothed this face was destroyed by fire, and the duced tussock association grazed continuously for seventy years. oday a whole range of soil depletion forms is present: a number of cipient and fully developed gullies, talus cones, areas of wind stripping, eet wash and frost heave, and a few healed 'slips'. With its wide nge of vegetation associations and soil depletion types, Mt. Ida is one the most comprehensive sections of the Lake Coleridge catchment. deed it displays a variety of problems pertinent to the Canterbury gh country as a whole, and might well be used as a 'laboratory' ock for research into high country problems.

A most remarkable form of accelerated erosion occurs on the shore of Lake Coleridge where, as a result of raising the lake level, a rejuvenated discontinuous cliff has been produced. In order to increase its storage capacity, the lake level was raised six feet in three successive stages. Wave cutting has been accelerated, especially during strong nor'west winds when the glacial till forming the lake shore from Peak Hill to the south is pounded by high breakers. An alongshore current carries the shingle towards the intake tunnels of the hydroelectric station. To protect the intakes two groynes have had to be constructed and an increasing amount of shingle has had to be removed from the beach formed in front of the northern groyne. Lake-edge slipping due to wave action has occurred along almost the whole of the lakeside. Access to the lake for sheep has deteriorated, and tussock slopes have become sliding shingle or bare rock. These problems would be aggravated by any further increase in the lake level. The importance therefore, of maintaining an adequate flow of water in the Harper and Avoca Rivers at all seasons is further emphasised.

Deterioration has led to 'excessive' erosion in a few areas only, but the major part of the lowland grassland shows signs of increasing degeneration. The farming policy practised on these marginal lands must inevitably lead to further degeneration.

Abandonment of the grasslands of Lake Coleridge would be unwise, for it would not eliminate accidental fires and grazing by vermin. Rotational spelling of the grasslands for periods of three years to give reseeding tussocks a chance of establishment may offer some solution. The three hundred odd acres of exotic plantation at Lake Coleridge Power Station suggest a possible line of development. Since 1914 experimental plantings of over forty-five different types of conifers have been made, and results show that *Pinus radiata* and Douglas fir (*Pseudotsuga taxifolia*) both have economic possibilities. It is estimated that 70 year Douglas fir and 35 year *Pinus radiata* rotations would be a milling proposition in this area. Once shelterbelts are established on the level areas about the Peninsula, winter feed crops might be grown, and the sheep helped over the lean months. Cultivation and manuring should make possible the growing of lucerne for hay. An alternative to cultivation would be the surface sowing and topdressing of good quality grasses and clovers. The introduction of a certain proportion of beef cattle into the run economy might prove useful. Willing to graze on shady faces, on scrub, and on rank growth generally, cattle may obviate the necessity for burning scrub. However, the experience f other Canterbury runholders shows that cattle cannot be made to raze on a large block where wanted, and further subdivisional fencing ould be necessary.

Before any successful scheme of conservational grazing can be troduced in the Lake Coleridge catchment, two conditions must e met. Firstly, wild animals, deer, rabbits and hares, must be destroyed. econdly, the tussock grasslands should be subdivided into small blocks enable rotational grazing and pasture spelling to be practised. Though any runholders recognise the desirability of such measures, the xpense of fencing and vermin destruction is beyond their financial sources today. It should be recognised as a national duty to keep the ssock grasslands of the high country at once adequately vegetated and onomically productive.

Subalpine Vegetation

A most significant factor underlying the present day problems of il erosion and accelerated run-off is the extensive depletion of the igh altitude (4000 feet and over) vegetation. The subalpine community f snowgrass and associated plants has suffered an areal decrease of ghty percent, from 45,700 to 9700 acres. The south face of the raigieburn Range once clothed with a more or less continuous owgrass and fescue tussock cover, is now a mass of moving shingle. n the higher slopes of the Big Ben Range almost every particle of rface soil has been swept away and a creeeping mat of dwarf heath the only plant surviving amongst the residual shingle. The Grey,[11] irdwood and Black Ranges are streaming wastes of grey talus relieved nly here and there by 'islands' of yellow-brown vegetation. The ntly-domed tops of Mt. Gargarus and Cottons Sheep Range are rgely bare of tussocks; parts of them are in the last stages of vegetative egeneration, as only the drought resistant scabweed remains on wind d frost-eroded surfaces. In the entire catchment there is no large area f continuous vegetation above 4000 feet (Fig. 3).

Few new elements have been introduced into the high altitude flora. he only 'foreign' plant present in quantity is sorrel (*Rumex acetosella*). hough this is a weed on good quality, lowland pastures, no plant can be nsidered a weed when growing under the rigorous and inhospitable nditions of subalpine shingle wastes. Three factors are responsible r the depletion of subalpine plant life: burning of rank tussock growth,

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ee footnote, p. 32.

summer grazing by merino sheep, and the depredations of deer, chamois and hares. In Front Basin Creek[11] charred dead-hearted bunches of snow grass indicate a recent burn. In other top basins even dead tussocks can no longer be found. Musterers' signal fires have been, and still are, lit frequently in the subalpine zone and cause much greater damage than those lit in the lower tussock country. Areas burnt by signal fires have little chance of recovery for few plants can become established under conditions of ever active frost heave, talus creep, and wind stripping, as well as occasional grazing. The large saucer-shaped loess-mantled hollow immediately to the lee of Mt. Oakden peak appears to have had a primitive carpet of *Danthonia setifolia*. An early musterer probably burned this flat basin. The widely foraging merino took its toll of the plant cover. The thick carpet of danthonia wore thin; frost and wind rapidly enlarged the bare patches until only one third of the plant cover remains. Isolated 'mesas' of danthonia stand today eight feet or more above the surrounding eroded clay subsoil, their edges windblown and overhanging, a litter of broken-off sods around the base.

Perhaps more destructive in its effect on the plant cover than fire or sheep has been the grazing of deer, chamois and hares. Hares are not normally associated with high altitudes, but large fat hares are frequently disturbed when crossing a top basin, and hare tracks and droppings are found even in the snow high up on the Black and Grey Ranges. In areas where the 'balance of nature' is delicately poised, even the light grazing by these animals has a significant effect on the plant cover. In heavy snowfall deer may be snowbound in a top basin for a considerable period. Every plant, whether normally eaten or not, is nibbled hard back. Such localised destruction, combined with the normal summer grazing of herds of up to thirty deer, has almost completely destroyed the vegetation of many sunny, windswept and rain-scoured top basins.

Bare patches have been attacked by sheet erosion, wind stripping and frost heave. Deer tracks have become channels of increasing size and depth, down which water rushes with every rain. Moving shingle however is the dominant form of accelerated erosion in high altitudes. Exfoliation and rock decay are rapid. Diurnal temperature changes are marked and the agents of normal erosion active. Grey, freshly exfoliated shingle streams downwards burying sturdy snow tussocks beneath its increasing flow.

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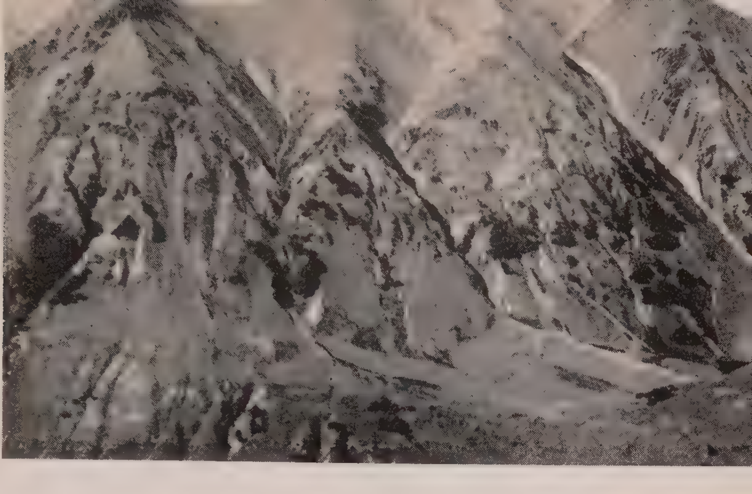
[11] See footnote, p. 32.



Devegetation of
ly face of Mt. Ida
. followed by soil
n. Gully talus and
nd-frost erosion
all apparent.

Typical of the fate
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On this slope at
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ed with gullies,

It is apparent that with eighty percent of its primitive plant cover gone, the high altitude belt of vegetation affords little protection to the skeletal soil. Almost all of the 'excessive' and a large proportion of the 'much' eroded parts (Fig. 8) are confined to this zone, as are the areas of 'very poor' and' poor' vegetation condition (Fig. 7). Geologic erosion is at a maximum, but it is an error to regard the forces of depletion as purely geologic. Man, through medium of fire, sheep, deer, chamois, and hares, has weakened or destroyed most of the plant cover. Once this protective cover is breached, geologic forces become abnormally active. Such forces are however, initially *man accelerated.* At such high altitudes and under such rigorous climatic conditions, normal conservational practices cannot be applied. The solution, if any, seems to lie in the complete retirement of these marginal pastures from sheep grazing and in destruction of the vermin. Natural reseeding and regeneration may then proceed unchecked.

Beech Forest

When viewed from afar, the dark green mantle of *Nothofagus* appears to be in its primitive condition, and is often thought to afford ideal soil protection. This may still be so in beech areas elsewhere in alpine Canterbury, but in the Harper and Avoca valleys the mountain beech forest has suffered serious damage, and its condition is a matter for concern. Covering in pre-European times a critical 31,800 acres, about twenty percent of the total catchment area, *Nothofagus* forest probably provided a very effective check to the spring run-off of melting snow from the top basins. Today, not only has the forest area been intentionally reduced by fire to half its former area, but the water retentivity of its floor has been greatly impaired. The primitive forest floor covering of mosses, lichens, scattered liverworts, ferns and beech seedlings has well nigh disappeared. No native plants or exotic weeds have replaced this cover. With the protective mosses gone, the litter of dead leaves, twigs, and tree trunks is unanchored and is liable to be swept away by surface run-off during periods of heavy rainfall.

For this conditon, deer are almost entirely responsible. One does not need to travel far in the beech forest of the Harper and Avoca to find evidence of their presence. Deer trails are innumerable, saplings are frequently ring-barked by antler rubbing, deer skeletons by no means uncommon. The number of deer present in the catchment is a matter of conjecture. In 1939-1940 a party of government cullers shot ut 700 deer and 200 chamois in the area. Two years later a follow-up y destroyed approximately 880 deer. Yet despite this severe culling are again abundant, and it is by no means unusual to surprise a herd wenty. It appears that the seldom-visited valleys of the Harper and ca lying between the 'thoroughfares' and frequently shot-over s of the Waimakariri and Wilberforce valleys, provide a *cul de sac* ch is a refuge to these shy animals. Persistent and frequent culling be necessary if the beech forest in these two valleys is to have a nce of regenerating.

The forms of soil erosion are much less complex in the beech forest in the other plant associations in the catchment. Frost erosion is of ted extent, and sheet wash, though common, has seldom affected complete removal of the surface humus litter. Faunal, i.e. animal ion, is apparent in some localities where deer trails leading uphill become small gullies. But these forms are dwarfed by the steel talus slides which lash through the beech forest. Discordant forest es and trees buried two feet or more and frequently killed by shingle mulation both afford clear evidence of accelerated erosion. The ce of moving shingle, however, is generally in the subalpine area re the plant cover has been destroyed by fire or vermin. It is well wn that if such shingle slides are stable for a period, a fringe of ling beech extends from the flanking forest. On the other hand, if supply of shingle is maintained no such fringe can extend. Only in very small areas do growing fringes of seedling beech indicate e shingle slides. Elsewhere the line of contact between beech and gle is markedly discordant.

Avalanches may cause much damage to beech forest when snow eps down beech-lined 'couloirs' and tears away the trees which ede its path. Avalanche destruction occurred in primitive times, today, with the forest floor cleaned of its natural moss cover, young take much longer to clothe the scoured shingle surface.

The condition of the beech forest in the Lake Coleridge catchment pares unfavourably with other mountain beech associations. It is grazing ground of about 400 deer. For a quarter of a century or this relatively intensive beech forest grazing has proceeded unked, as far as could be ascertained, except by the two major culling ations mentioned above. If no further action is taken to destroy deer, the forest will inevitably be killed.

One of the most serious 'problem' areas in the catchment today is the induced tussock belt in the lower Avoca valley. Conditions he show that tussock grassland is unable to anchor the soil as effective as the native beech forest. This example of beech forest destructic makes it clear that the forested area cannot be further reduced witho gravely accentuating the present problems of deterioration. Water ar soil conservation in this catchment demands forest conservation.

Conclusion

From the viewpoint of conservation of vegetation, water and so the Lake Coleridge catchment is a problem area. Disturbance of tl fine state of balance of the primitive vegetation by the early and sul sequent fires, by the introduction and grazing of vermin, and by tl continued overgrazing of merino sheep, has reduced the plant cover l no less than thirty percent. Five-sixths of the vegetation cover is in critical condition, four-fifths of the catchment suffers from apparen soil erosion, surface run-off has increased, and water retentivit decreased. The areas of greatest soil loss and poorest vegetation con dition are those areas of highest altitude and most active geolog erosion. The following measures seem necessary if stability is to l restored, and vegetation, soil and water conserved. The subalpine are should be retired from grazing, and along with the mountain beec forest, rid of deer and other vermin. A system of rotational grazing ar long-term spelling, in conjunction with the complete cessation of a burning, is necessary on the tussock grasslands.

These measures, however, will do little to alleviate the all-importar economic problem facing high country farmers. With the recer relatively low prices for fine wool, and the high costs of productior many high country farmers were finding it difficult to carry or Abandonment to vermin no more solves the national problem of fir wool and breeding ewe production than the equally national probler of vegetation, soil and water conservation. The problem appears t demand also a detailed investigation of the economics of high countr farming.

THE EQUIDISTANT AZIMUTHAL PROJECTION OF THE SPHERE

L. P. LEE

HE EQUIDISTANT azimuthal projection is a system of map
projection designed to represent correctly the direction and
nce from some selected point to every other point of the sphere.
re 1 illustrates how this requirement is achieved. The drawing
: left is a perspective view of the sphere showing the great circle
es from the point O to several other points; at the right, these
great circles are represented on a map with the point O as origin.
great circle is, as it were, straightened out so that all of them lie
e same plane, but each preserves its correct length and the correct
which it makes with each of the others. Hence, if the map is
ided with a protractor scale and a scale of distances, the azimuth
rue bearing) and the distance, from the origin to every other point,
be found by direct measurement.

the simplest case, the origin is a geographic pole. Great circles
ting from the pole are meridians; in this case, therefore, the
lians are represented by straight lines radiating from the pole, and
arallels by equidistant concentric circles. In the general case, where
rigin may be any point on the sphere, the graticule (or network
eridians and parallels) is more complicated. Two such maps are
rated in Figs. 2 and 3, the first with the origin at London, the second
the origin at Wellington.[1]

e name, equidistant azimuthal, emphasizes the properties of the
ction. The azimuthal projections are those in which straight lines
igh the origin preserve the azimuths of the great circles which they
sent, while the description, equidistant, implies that the distance
een any two points on one of these straight lines is equal to the
nce between the corresponding points on the sphere. When this
ction is used for the representation of the celestial sphere or of a
ial hemisphere, the origin represents the observer's zenith, and the
uthal projections are often known as the zenithal projections. It is
n appropriate description for terrestrial maps.

any system of map projection, it is impossible to represent all

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s of the map of the world on an equidistant azimuthal projection, with Wellington as the
on a scale of about 1420 miles to an inch, may be obtained from the Lands and Survey
tment.

azimuths and distances correctly; if some are represented correct then others must suffer distortion. The great circles radiating from on the sphere in Figure 1 begin to converge again when they cross i the hemisphere remote from O, and they finally meet at the antipo of O. On the projection, however, they continue to diverge over t whole extent of the map, and the point antipodal to the origin

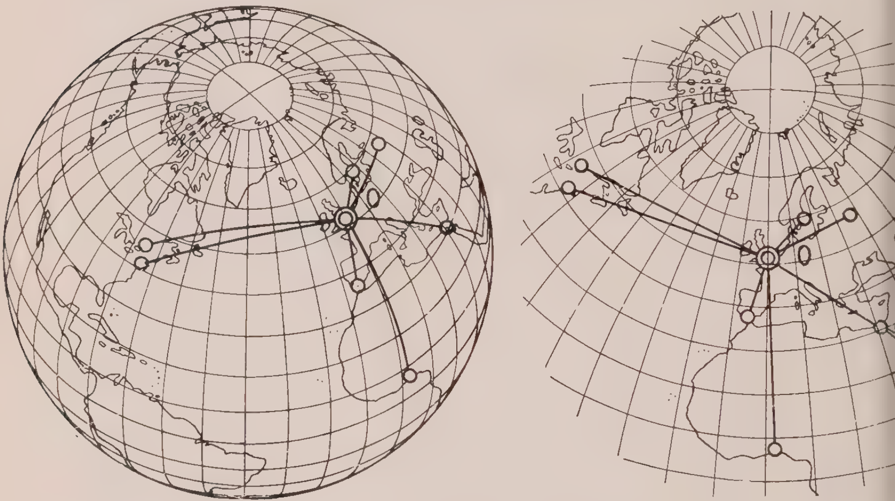


Fig. 1. Great circles radiating from a point on the sphere (*left*) and their representation o equidistant azimuthal projection with that point as origin (*right*).

represented by the circular boundary. Thus, although the scale rema correct along a radius of the map, there is an enlargement of scale acr a radius. This enlargement increases with the distance from the orig ultimately becoming infinite when the antipodes of the origin is reach This results in very great distortion of the shapes of countries near boundary of the map, as can be seen from Figures 2 and 3.

The map represented in Figure 2, in common with most m constructed with a city of the northern hemisphere as origin, is f tunate in that the point antipodal to the origin falls in the sea, and distortion of the land areas is not so noticeable. The antipodes Wellington, however, is a point in Spain, so that, in the map represen in Figure 3, Spain extends completely around the boundary, and ot countries in Europe are barely recognizable. For purposes of co parison, the great circle joining London and Wellington has b shown on both maps. The distance between any two points on great circle is represented to the same scale on each map, but this is only line which the two maps have in common.

ıe meridian of the origin is the north-south axis of the projection. ;ure 2, the origin has been chosen on the Greenwich meridian ı is represented by the median straight line. The other meridians, ı at ten degree intervals of longitude, are symmetrical about the -south axis. In Figure 3, the origin is at east longitude 174° 47′, ıe meridians which are actually plotted are not symmetrical about xis; they are very nearly so, however, since the origin is nearly ay between the 170° and 180° meridians. In all cases, the parallels mmetrical about the axis. The parallel of the point antipodal to igin (it is not drawn in Figures 2 and 3) extends across the map, ng the boundary at azimuth 270° at the western edge and at ıth 90° at the eastern edge, and separates the parallels which are curves around the north pole from those which are closed curves d the south pole. The circular boundary of the map, since it ents the point antipodal to the origin, represents part of the el as well as part of the meridian of that point.

part from its interest to anyone who likes to know in what ion the rest of the world lies, a map on the equidistant azimuthal tion has considerable practical value. It is useful to aircraft anies in studying great circle routes from a terminal airport, or to ng companies if the origin is a seaport. More important today use in long-distance radio communication. It can be used at a uitting station to determine how signals should be directed to be ed by a particular station, or at a receiving station to determine rection from which signals should arrive. Moreover, the map ıtes the great circle route between stations, and factors likely to signal transmission such as the nature of the region traversed, er it is land or water, or whether it lies in or near an auroral zone, e conveniently studied.

e equidistant azimuthal projection was a product of the recrud-e of interest in cartography manifested during the Renaissance. rliest known instance of its use is that by Glareanus who included of the world in two hemispheres on a polar equidistant azimuthal tion in a treatise written about 1510. In 1582 it was used by ume Postel, by whose name the projection is known in France, the same year it was used by Sir Humphrey Gilbert to illustrate orth-west passage'. Johann Heinrich Lambert, whose work d a new era of mathematical cartography in 1772, included this tion in his general investigations, citing it as a member of the

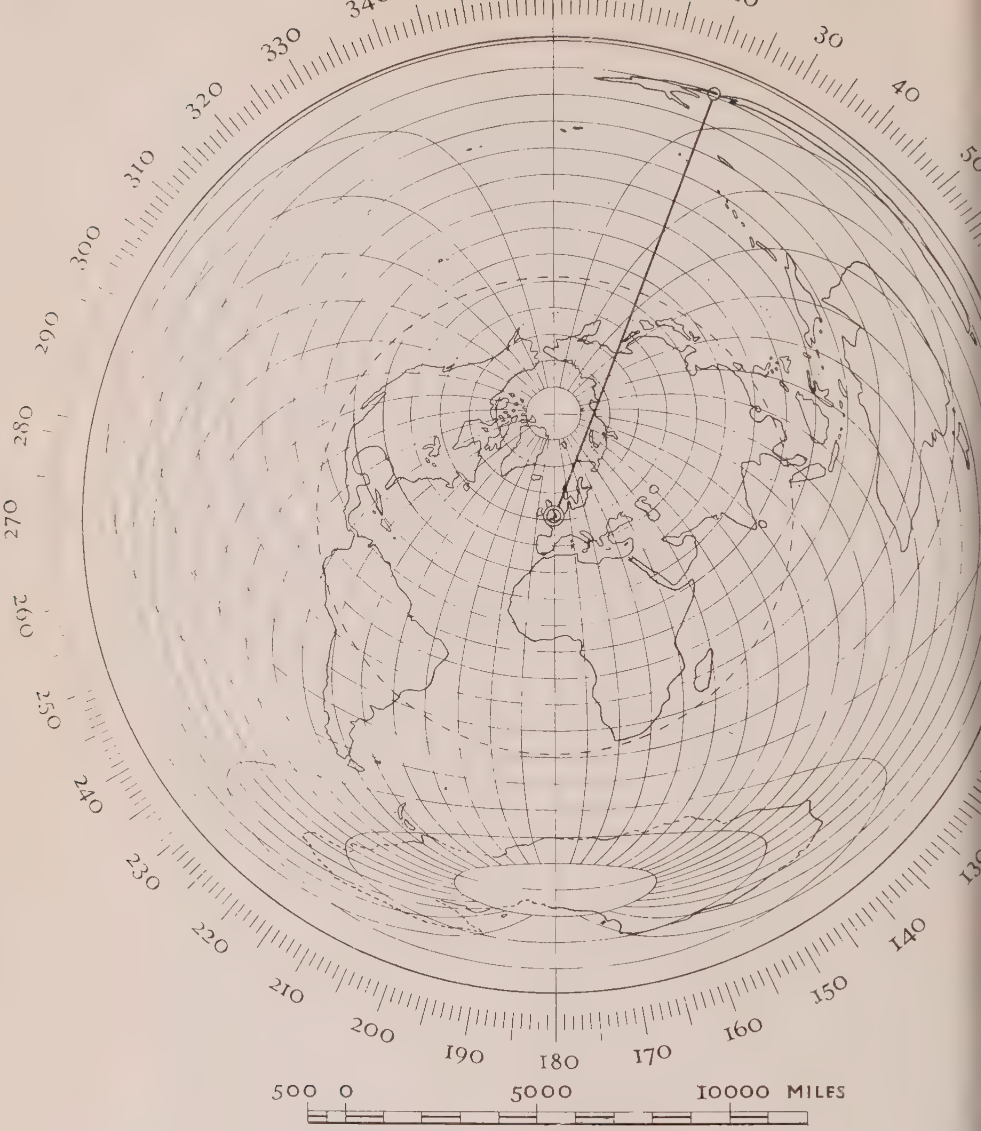
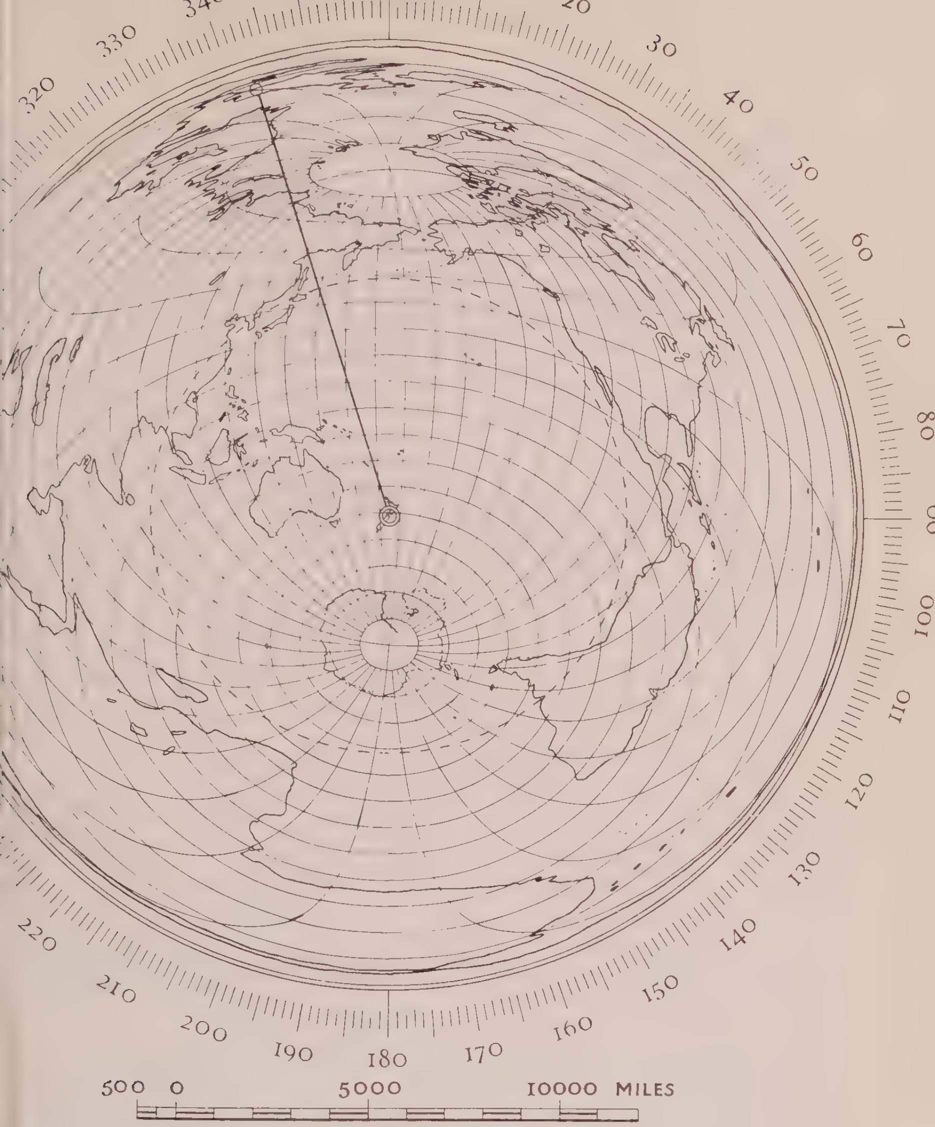


Fig. 2. Equidistant azimuthal projection of the world with origin at London. The scale of i
applies only to distances between points on the same straight line through London; the d
circle is the boundary of the hemisphere centred on London.

azimuthal or zenithal class. In 1799 Antonio Cagnoli bestowed his o
name upon it in the belief that he had invented it for the first ti
It was well known in the 19th century, and appears in several c
tinental atlases of the period, including Schrader's *Atlas de Géogra*
Moderne (Paris, 1896), and Debes's *Neuer Handatlas* (Leipzig, 18
It is featured, but not mentioned by name, in the Erpi Classroom Fi
The Airplane Changes our World Map (Encyclopaedia Britannica Fil
Inc.). In view of this history, it is surprising to find an American
transport company publishing a map of the world on a polar c



Equidistant azimuthal projection of the world with origin at Wellington. The scale of pplies only to distances between points on the same straight line through Wellington; the dotted circle is the boundary of the hemisphere centred on Wellington.

t azimuthal projection three or four years ago, and claiming it as 'a method of projection'!

evertheless, the equidistant azimuthal projection has not been as extensively as it might have been, no doubt because of the treatment it receives in textbooks, and because it might be ed from the fearsome appearance of the graticule that intricate aborious computations are involved. This article purports to show on the contrary, it is not a difficult projection to establish, and that are several useful dodges by which the computing and plotting e made remarkably simple.

FUNDAMENTAL FORMULAE OF THE PROJECTION

Since the characteristic property of the projection is the correct representation c the azimuths and distances from the origin to all other points, it is very simply con structed by computing the azimuth and distance from the origin to each of the require graticule intersections, and using these as polar coordinates for plotting the graticule.

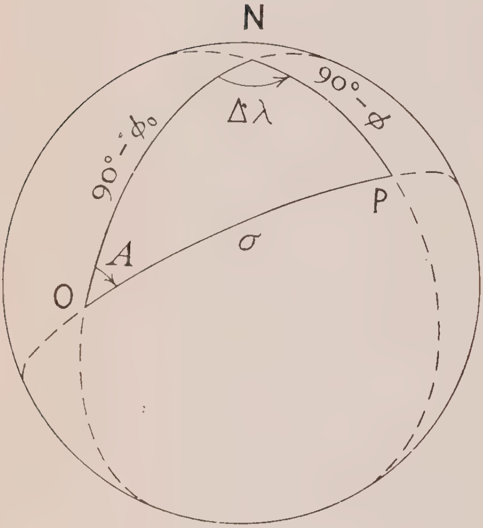


Fig. 4. Spherical triangle determining the elements of the projection.

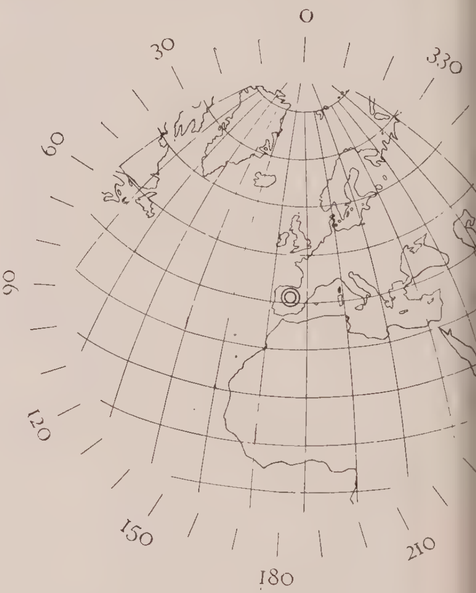


Fig. 5. Auxiliary projection used in plotting t shown in Fig. 3. The origin is the point i antipodal to Wellington.

In Figure 4, O is the point selected as the origin of the projection, P the point who coordinates are required, and N the geographic pole. A spherical triangle is forme by NO (the meridian of O), NP (the meridian of P), and OP (the great circle from to P), and solution of this triangle will give the required azimuth *A*, and spherical a distance σ, from O to P. If ϕ_0 is the latitude of O, and ϕ the latitude of P, then t sides NO and NP of the spherical triangle are $90° - \phi_0$ and $90° - \phi$ respectively. T angle at N is the difference of longitude of P from O, so that, if λ_0 is the longitu of O, and λ that of P, then this difference of longitude is given by $\Delta\lambda = \lambda - \lambda_0$.

The formulae of spherical trigonometry applied to this triangle give the expressio

$$\cot A = \frac{\cos\phi_0 \tan\phi - \sin\phi_0 \cos\Delta\lambda}{\sin\Delta\lambda}, \qquad (1)$$

$$\cos\sigma = \sin\phi_0 \sin\phi + \cos\phi_0 \cos\phi \cos\Delta\lambda, \qquad (2)$$

from which *A* and σ may be found.

In the application of these formulae, north latitudes and east longitudes are co sidered positive, south latitudes and west longitudes negative, and azimuth is reckon clockwise from the north. There is no uncertainty as to the quadrant in which t ith A lies, since points east of the origin ($\triangle\lambda$ positive) will be located at azimuths ng from 0° to 180°, and points west of the origin ($\triangle\lambda$ negative), at azimuths 180° to 360°. The spherical arc distance σ ranges from 0° to 180°, and may be rted from angular to linear measure, if required, from a knowledge of the radius e sphere. The polar coordinates, A and σ, are all that is required for the con- on of the projection, but they may be converted to rectangular coordinates in ual way by multiplying the distance σ by the sine and by the cosine of the uth A.

or points on the meridian of the origin O, $\triangle\lambda=0$, and the formulae become,

$$\cot A=\infty\,,$$

$$\cos\sigma=\sin\phi_0\sin\phi+\cos\phi_0\cos\phi=\cos(\phi-\phi_0).$$

e. the azimuth is 0° or 180°, and the spherical arc distance is the difference of de of the point from the origin, a result that is obvious from the nature of the tion.

or other points, the formulae may be modified according to whether the com- n is to be performed by calculating machine or by logarithms.

COMPUTATION BY CALCULATING MACHINE

or the computation of the graticule intersections, at regular intervals of latitude ongitude, using natural functions with a calculating machine, the formulae (1) 2) may be written in the form,

$$\cot A=[-\sin\phi_0\cot\triangle\lambda]+[\cos\phi_0\operatorname{cosec}\triangle\lambda]\tan\phi, \qquad (3)$$

$$\cos\sigma=[\sin\phi_0\sin\phi]+[\cos\phi_0\cos\phi]\cos\triangle\lambda. \qquad (4)$$

simplicity of these expressions is more readily appreciated if the bracketed functions placed by italic letters, when they take the form,

$$\cot A=a+b\tan\phi, \qquad \cos\sigma=c+d\cos\triangle\lambda.$$

ry computation, the values of a, b, and $\cos\triangle\lambda$ are tabulated for the ired range of longitudes, since these functions are constant for any one meridian. arly, the values of c, d, and $\tan\phi$, which are constant along a parallel, are tabulated st the latitude. Differences are entered for $\cos\triangle\lambda$ and for $\tan\phi$.

he azimuths are first computed along a meridian. The appropriate value of a e meridian concerned is turned into the product dial, and the corresponding of b is set on the keyboard. The keyboard figures are then multiplied by the priate value of $\tan\phi$, giving, in the product dial, the value of $\cot A$ for the atitude. Then, without clearing the dials, the multiplier $\tan\phi$ is altered to its alue by means of the differences already entered in the tables, the second value A being thus obtained. The same process is continued until all the values of for that meridian are completed. If the machine has a 'true figure' multiplier he correct value of $\tan\phi$ will, of course, appear there at each stage; but, if a ne with a 'black and red figure' type of multiplier dial is used, that dial should ared before each multiplication, so that the differences registered there may be d if necessary. Even with a hand-operated calculating machine, the process s simple and rapid, but, with an electric machine equipped with automatic multiplication and automatic carriage return, the computations for one meridia may be completed in two or three minutes.

The spherical arc distances are computed in a similar manner, but this tim working along a parallel instead of along a meridian. The appropriate value of *c* fo the parallel is set in the product dial, and the corresponding value of *d* on the keyboard the multiplier cos △ λ varies with the longitude.

An example of the computation of points on one meridian is given below. Th origin in this case is latitude −41° 18′, longitude +174° 47′, roughly the centre o Wellington City, and the graticule intersections are required at ten degree intervals The first few values of the auxiliary tables are as follows.

Functiôns tabulated against the longitude:

λ	△ λ	*a* −sin Ø₀ cot △ λ	*b* cos Ø₀ cosec △ λ	cos △ λ	Diff.
°	° ′				
0	−174 47	+7·228 8996	−8·262 7078	−0·995 8580	
					030 917
10 E	−164 47	+2·426 4199	−2·862 2870	— 964 9402	
					060 237
20	−154 47	+1·401 5166	−1·763 3550	— 904 7032	
					087 726
30	−144 47	+0·935 0345	−1·302 7627	— 816 9772	
....	......	....	....	....	

Functions tabulated against the latitude:

Ø	*c* sin Ø₀ sin Ø	*d* cos Ø₀ cos Ø	tan Ø	Diff.
°				
80 N	−0·649 9748	+0·130 4556	+5·671 2818	
				2·923 8044
70	— 620 1987	+ 256 9475	+2·747 4774	
				1·015 4266
60	— 571 5782	+ 375 6321	+1·732 0508	
				0·540 2972
50	— 505 5906	+ 482 9033	+1·191 7536	
....	....	....	....	

With meridians at ten degree intervals, and origin at longitude +174° 47′, th extreme meridian to be shown in the hemisphere west of the origin will be the Greenwich meridian. When the auxiliary tables are complete, the computation of points o the Greenwich meridian then proceeds thus:

Meridian 0°

Ø	cot *A*	*A*	cos σ	σ
°		°		°
80 N	−39·63124	358·55	−0·77989	141·25
70	−15·47270	356·30	— 87608	151·17
60	— 7·08253	351·96	— 94565	161·02
50	— 2·61821	339·10	— 98649	170·57
..	....	......	....	......

The computation of the successive values of cot A is carried down the column in
nanner already explained. In computing the values of cos σ, however, the work is
d across a parallel; the first value computed for latitude 80°N is entered under
dian 0° as shown, the second value obtained is entered under meridian 10°E,
o on, the machine being finally cleared before the process is repeated for latitude
.

The units in which A and σ are expressed will depend upon the scale to which
nap is to be drawn, or upon the trigonometric tables available. In the above
ples, they are expressed in degrees and decimals of a degree, very convenient
for plotting, the values being obtained from Peters's *Seven-place Values of Trigo-*
ric Functions for every Thousandth of a Degree. If the more familiar *Chambers's*
-Figure Mathematical Tables, or other tables with sexagesimal arguments, are
the results may be expressed in degrees and minutes. In this case, the spherical
istance σ is converted to minutes for plotting purposes, an extra column being
required in the lay-out for each meridian.

When the positions of particular cities are required, there is no longer any advan-
in constructing tables of auxiliary functions which are constant for a given
de or a given longitude, since no two of the points required will lie on the same
lel or the same meridian. Formulae (3) and (4) can still be used, but in each case
cond term, involving the product of three functions, should be evaluated first,
ther term, involving the product of two functions, being then applied to the
in the product dial. The product of three functions, however, involves a transfer
gures from the product dial to the keyboard and the subsequent clearing of
eded figures remaining in the product dial. It is possible to avoid this by a re-
gement of the original formulae (1) and (2), and they are now written in the form,

$$\cot A = \frac{\cos \phi_0 \tan \phi - \sin \phi_0 \cos \triangle \lambda}{\sin \triangle \lambda} \qquad (5)$$

$$\cos \sigma = \frac{\sin \phi_0 \tan \phi + \cos \phi_0 \cos \triangle \lambda}{\sec \phi}. \qquad (6)$$

variables are denoted by italic letters, these become

$$\cot A = \frac{e \cos \phi_0 - h \sin \phi_0}{g}, \quad \cos \sigma = \frac{e \sin \phi_0 + h \cos \phi_0}{f}.$$

expressions require, for each point, only four variable functions to be extracted
tables, instead of five if the first method were used. Moreover, the right side of
expression involves the sum or difference of two products which may be accumu-
in the product dial, the result then being divided by the appropriate function
out any transfer of figures. These formulae are particularly well adapted for
ic machines equipped with automatic division.

xamples of the application of these formulae in some typical cases follow, the
n as before being at latitude $-41^\circ\ 18'$, longitude $+174^\circ\ 47'$, and the constants

$$\sin \phi_0 = -0{\cdot}660\ 0017, \qquad \cos \phi_0 = +0{\cdot}751\ 2641.$$

	London	New York	Buenos Aires	Capetown
ϕ	$+\ 51^\circ\ 31'$	$+\ 40^\circ\ 43'$	$-\ 34^\circ\ 36'$	$-\ 33^\circ\ 56'$
λ	$-\ 0^\circ\ 06'$	$-\ 74^\circ\ 00'$	$-\ 58^\circ\ 22'$	$+\ 18^\circ\ 25'$
$\triangle\lambda$	$-174^\circ\ 53'$	$+111^\circ\ 13'$	$+126^\circ\ 51'$	$-156^\circ\ 22'$
$e = \tan\phi$	$+1{\cdot}257\ 9232$	$+0{\cdot}860\ 6419$	$-0{\cdot}689\ 8538$	$-0{\cdot}672\ 8169$
$f = \sec\phi$	$+1{\cdot}606\ 9757$	$+1{\cdot}319\ 3576$	$+1{\cdot}214\ 8655$	$+1{\cdot}205\ 2728$
$g = \sin\triangle\lambda$	$-0{\cdot}089\ 1840$	$+0{\cdot}932\ 2186$	$+0{\cdot}800\ 2083$	$-0{\cdot}400\ 8821$
$h = \cos\triangle\lambda$	$-0{\cdot}996\ 0152$	$-0{\cdot}361\ 8958$	$-0{\cdot}599\ 7221$	$-0{\cdot}916\ 1297$
$\cot A$	$-3{\cdot}22548$	$+0{\cdot}43736$	$-1{\cdot}14230$	$+2{\cdot}76917$
A	$342^\circ{\cdot}77$	$66^\circ{\cdot}38$	$138^\circ{\cdot}80$	$199^\circ{\cdot}86$
$\cos\sigma$	$-0{\cdot}98228$	$-0{\cdot}63660$	$+0{\cdot}00391$	$-0{\cdot}20261$
σ	$169^\circ{\cdot}20$	$129^\circ{\cdot}54$	$89^\circ{\cdot}78$	$101^\circ{\cdot}69$

COMPUTATION BY LOGARITHMS

The original formulae (1) and (2) may be put into a form suitable for logarithm computation by the introduction of two auxiliary angles defined by the relatio

$$\tan\theta_1 = \tan\phi_0 \cos\triangle\lambda, \qquad \cot\theta_2 = \cot\phi_0 \cos\triangle\lambda,$$

where θ_1 and θ_2 are constant for any one meridian. The expression (1) for azimu then becomes

$$\begin{aligned}\cot A &= \frac{\cos\phi_0\,(\tan\phi - \tan\phi_0\cos\triangle\lambda)}{\sin\triangle\lambda}\\ &= \frac{\cos\phi_0\,(\tan\phi - \tan\theta_1)}{\sin\triangle\lambda}\\ &= \frac{\cos\phi_0\,(\sin\phi\cos\theta_1 - \cos\phi\sin\theta_1)}{\cos\phi\cos\theta_1\sin\triangle\lambda}\\ &= [\cos\phi_0\sec\theta_1\operatorname{cosec}\triangle\lambda]\sec\phi\sin(\phi-\theta_1), \qquad (7)\end{aligned}$$

and the expression (2) for spherical arc distance becomes

$$\begin{aligned}\cos\sigma &= \sin\phi_0\,(\sin\phi + \cot\phi_0\cos\phi\cos\triangle\lambda)\\ &= \sin\phi_0\,(\sin\phi + \cos\phi\cot\theta_2)\\ &= \frac{\sin\phi_0\,(\sin\phi\sin\theta_2 + \cos\phi\cos\theta_2)}{\sin\theta_2}\\ &= [\sin\phi_0\operatorname{cosec}\theta_2]\cos(\phi-\theta_2). \qquad (8)\end{aligned}$$

The functions in square brackets are constant for any one meridian, and their logarith may be evaluated first for the required range of longitudes.

The meaning of the quantities θ_1 and θ_2 is unimportant for the purposes of co putation, and they may be regarded merely as positive or negative acute angles. Th are, however, capable of a geometrical interpretation. In Fig. 4, let a great circ perpendicular to the meridian NO, be drawn from O to intersect the meridian of then θ_1 is the latitude of the intersection. Also, let a great circle be drawn from O make a rectangular intersection with the meridian of P; then θ_2 is the latitude of t intersection. Formulae (7) and (8) may be derived from the right-angled spheri triangles so obtained.

As an example of the use of these formulae, the results derived above by the ılating machine method are now obtained by logarithmic computation. The in of the projection is Wellington, and positions on the Greenwich meridian are ıired. As before, $Ø_0 = -41° \ 18'$, $\lambda_0 = +174° \ 47'$, and the preliminary computation he constants for the Greenwich meridian is therefore as follows:

For meridian 0°, $\Delta\lambda = -174° \ 47'$.

log tan $Ø_0$	$\bar{1}\cdot943 \ 7524$ n	log cot $Ø_0$	$0\cdot056 \ 2476$ n
log cos $\Delta\lambda$	$\bar{1}\cdot998 \ 1974$ n	log cos $\Delta\lambda$	$\bar{1}\cdot998 \ 1974$ n
log tan θ_1	$\bar{1}\cdot941 \ 9498$	log cot θ_2	$0\cdot054 \ 4450$
θ_1	$+41° \ 11'$	θ_2	$+41° \ 25'$
log cos $Ø_0$	$\bar{1}\cdot875 \ 7927$	log sin $Ø_0$	$\bar{1}\cdot819 \ 5450$ n
log sec θ_1	$0\cdot123 \ 4320$	log cosec θ_2	$0\cdot179 \ 4504$
log cosec $\Delta\lambda$	$1\cdot041 \ 3297$ n		
		log K_2	$\bar{1}\cdot998 \ 9954$ n
log K_1	$1\cdot040 \ 5544$ n		

With these preliminary results available, the computations may be arranged in ılar form thus:

Ø	+80°	+70°	+60°	+50°
$Ø-\theta_1$	$+38° \ 49'$	$+28° \ 49'$	$+18° \ 49'$	$+8° \ 49'$
$Ø-\theta_2$	$+38° \ 35'$	$+28° \ 35'$	$+18° \ 35'$	$+8° \ 35'$
K_1	$1\cdot040 \ 5544$ n	$1\cdot040 \ 5544$ n	$1\cdot040 \ 5544$ n	$1\cdot040 \ 5544$ n
sec Ø	$0\cdot760 \ 3298$	$0\cdot465 \ 9483$	$0\cdot301 \ 0300$	$0\cdot191 \ 9325$
sin $(Ø-\theta_1)$	$\bar{1}\cdot797 \ 1501$	$\bar{1}\cdot683 \ 0548$	$1\cdot508 \ 5850$	$\bar{1}\cdot185 \ 4665$
cot A	$1\cdot598 \ 0343$ n	$1\cdot189 \ 5575$ n	$0\cdot850 \ 1694$ n	$0\cdot417 \ 9534$ n
A	$358° \ 33'$	$356° \ 18'$	$351° \ 58'$	$339° \ 06'$
K_2	$\bar{1}\cdot998 \ 9954$ n	$1\cdot998 \ 9954$ n	$1\cdot998 \ 9954$ n	$\bar{1}\cdot998 \ 9954$ n
cos $(Ø-\theta_2)$	$\bar{1}\cdot893 \ 0412$	$\bar{1}\cdot943 \ 5549$	$1\cdot976 \ 7447$	$1\cdot995 \ 1084$
cos σ	$\bar{1}\cdot892 \ 0366$ n	$\bar{1}\cdot942 \ 5503$ n	$\bar{1}\cdot975 \ 7401$ n	$\bar{1}\cdot994 \ 1038$ n
σ	$141° \ 15'$	$151° \ 10'$	$161° \ 02'$	$170° \ 35'$

If the results obtained previously by the calculating machine method are expressed legrees and minutes instead of degrees and decimals of a degree, the last two values are 161° 01′ and 170° 34′, differing by 1′ from the values obtained by logarithmic ıputation. These discrepancies are due to rounding off the auxiliary angles θ_1 and to the nearest minute; when these quantities are carried to seconds, complete agreement between the two methods is achieved. But 1′ of arc is not a plottab error on the usual scales of world maps, so that an uncertainty of a unit in the minut is of no importance.

For the computation of the positions of particular cities, formulae (7) and (8) ma again be used, but, as in this case no two of the points required will lie on the sam meridian, the auxiliary angles must be evaluated separately for each point, and provision for these quantities must therefore be made in the computation column Since K_1 and K_2 are no longer constant for a series of points, their logarithms nee not be evaluated separately, the logarithms of cot A and of cos σ being obtained by th summation of five and of three logarithms respectively.

An alternative method of computation, involving fewer logarithms, is possib in this case, by the introduction of a single auxiliary angle defined by the relation,

$$\cot\theta = \cot\phi \cos\Delta\lambda.$$

The expression (1) for azimuth can now be transformed thus:

$$\begin{aligned}\cot A &= \cot\Delta\lambda\,(\cos\phi_0 \tan\phi \sec\Delta\lambda - \sin\phi_0)\\ &= \cot\Delta\lambda\,(\cos\phi_0 \tan\theta - \sin\phi_0)\\ &= \frac{\cot\Delta\lambda\,(\cos\phi_0 \sin\theta - \sin\phi_0 \cos\theta)}{\cos\theta}\\ &= \cot\Delta\lambda \sec\theta \sin(\theta - \phi_0), \qquad (9)\end{aligned}$$

and the expression (2) for spherical arc distance thus:

$$\begin{aligned}\cos\sigma &= \sin\phi\,(\sin\phi_0 + \cos\phi_0 \cot\phi \cos\Delta\lambda)\\ &= \sin\phi\,(\sin\phi_0 + \cos\phi_0 \cot\theta)\\ &= \frac{\sin\phi\,(\sin\phi_0 \sin\theta + \cos\phi_0 \cos\theta)}{\sin\theta}\\ &= \sin\phi \operatorname{cosec}\theta \cos(\theta - \phi_0). \qquad (10)\end{aligned}$$

The auxiliary angle θ is also capable of a geometrical interpretation. In Figure if a great circle is drawn from P to make a rectangular intersection with the meridi NO, then θ is the latitude of that intersection, and formulae (9) and (10) may derived from the right-angled spherical triangles so formed. For the purposes of computation, θ may be regarded merely as a positive or negative acute angle.

These formulae are now applied to the examples already used as an illustration the calculating machine method. The origin, as before, is latitude −41° 18′, longitu +174° 47′. The results exhibit small discrepancies when compared with the resu obtained by calculating machine. They are unimportant for plotting purposes, b may be eliminated by carrying the auxiliary angle θ to the nearest second or to t nearest ten seconds.

	London	New York	Buenos Aires	Capetown
$ø$	$+51° 31'$	$+40° 43'$	$-34° 36'$	$-33° 56'$
λ	$-0° 06'$	$-74° 00'$	$-58° 22'$	$+18° 25'$
$\triangle\lambda$	$-174° 53'$	$+111° 13'$	$+126° 51'$	$-156° 22'$
ot $ø$	1·900 3459	0·065 1775	0·161 2429 n	0·172 1031 n
s $\triangle\lambda$	$\bar{1}$·998 2660 n	$\bar{1}$·558 5835 n	$\bar{1}$·777 9501 n	$\bar{1}$·961 9569 n
t θ	$\bar{1}$·898 6119 n	1·623 7610 n	1·939 1930	0·134 0600
θ	$-51° 38'$	$-67° 12'$	$+49° 00'$	$+36° 18'$
$\theta - ø_0$	$-10° 20'$	$-25° 54'$	$+90° 18'$	$+77° 36'$
t $\triangle\lambda$	1·047 9789	$\bar{1}$·589 0657 n	$\bar{1}$·874 7470 n	0·358 9403
c θ	0·207 1240	0·411 7108	0·183 0571	0·093 7036
n $(\theta - ø_0)$	$\bar{1}$·253 7609 n	$\bar{1}$·640 2844 n	$\bar{1}$·999 9940	$\bar{1}$·989 7489
ot A	0·508 8638 n	1·641 0609	0·057 7981 n	0·442 3928
A	$342° 47'$	$66° 22'$	$138° 48'$	$199° 51'$
n $ø$	$\bar{1}$·893 6448	$\bar{1}$·814 4600	$\bar{1}$·754 2288 n	$\bar{1}$·746 8115 n
sec θ	0·105 6536 n	0·035 3335 n	0·122 2201	0·227 6686
s $(\theta - ø_0)$	$\bar{1}$·992 8984	$\bar{1}$·954 0291	$\bar{3}$·718 9966 n	$\bar{1}$·331 9035
s σ	$\bar{1}$·992 1968 n	$\bar{1}$·803 8226 n	$\bar{3}$·595 4455	$\bar{1}$·306 3836 n
σ	$169° 10'$	$129° 32'$	$89° 46'$	$101° 41'$

GENERAL REMARKS ON COMPUTATION

he formulae given above provide methods of computing A and σ independently, the initial data. An alternative method is to compute either one of these quantities, hen to derive the other from the equation,

$$\sin A \sin \sigma = \cos ø \sin \triangle\lambda,$$

n is, of course, merely the rule of sines applied to the spherical triangle of Figure 4. better, however, to compute both azimuth and distance independently, and, ially if only one computer is entrusted with the work, to use this relation as a on the results.

the origin of the projection is such that the meridians to be shown are symmet- disposed on either side of it, then the curves which represent these meridians be symmetrical about the north-south axis of the projection. In general, the n will be a particular city, and the meridians which are actually plotted will not mmetrical about the axis. Even in this case, however, only one hemisphere need mputed. It is a property of antipodal points that they lie 180° apart on the same circle through the origin, and therefore, when the distance and azimuth to any oint have been computed, the antipodal point is found at the supplement of that ice and at that azimuth reversed. Hence, when the polar coordinates of points ie meridian have been derived, those of the corresponding points on the anti- lian may be written down at once. The following example illustrates how, from ositions of points on the Greenwich meridian as computed above, the positions of itipodal points on meridian 180° may be written down.

On meridian 0°

ø	A	σ
°	°	°
80 N	358·55	141·25
70	356·30	151·17
60	351·96	161·02
50	339·10	170·57
..	......	......

On meridian 180°

ø	A	σ
°	°	°
80 S	178·55	38·75
70	176·30	28·83
60	171·96	18·98
50	151·10	9·43
..	......	......

It will be seen in the next section, however, that the positions of the antipodal poin need not be written down; points on meridian 180° can be plotted directly from th positions computed for points on meridian 0°, and similarly for other pairs of antipod meridians.

The distance σ, as computed, is in angular measure, and in the above examples ha been shown either in degrees and decimals of a degree or in degrees and minute These are quite sufficient for plotting the projection (although, in the second case, the are more convenient when converted to minutes), but for other reasons this distanc may be required in linear units. To effect this conversion requires a knowledge of th radius of the sphere. A convenient mean value of this radius is the arithmetic mean the three semi-axes of the spheroid which most nearly corresponds to the know dimensions of the earth. Using the data of the 'international spheroid', the mea radius of the earth is 6 371 229·315 metres or 3 958·905 miles. The mean circumferenc is therefore 40 031 614·421 metres or 24 874·535 miles. From these values, the conversion factors,

$$1^\circ = 111\,198{\cdot}929 \text{ metres} = 69{\cdot}096 \text{ miles},$$

$$1' = 1\,853{\cdot}315 \text{ metres} = 1{\cdot}152 \text{ miles},$$

are easily derived. Spherical arc distances in degrees or minutes are therefore ver simply converted into linear distances in metres or miles.

Plotting the Graticule

If the spherical arc distances have been computed in degrees and decimals of degree, a convenient scale for plotting is 10° to an inch, resulting in a map of 18 inch radius; if the spherical arc distances have been computed in minutes, a suitable sca is 1000′ to an inch, which yields a map of 10·8 inches radius. When the scale of th map has been selected, a circle to contain the projection is drawn, and this circle is the graduated in degrees. If the scale of the map warrants it, each degree is subdivided int smaller units (tenths or sixths); these are helpful in plotting, though they need not b retained on the finished map.

The graticule intersections are then plotted from the computed polar coordinate the azimuths being measured on the graduated circle, and the spherical arc distanc being measured outwards from the centre. When the points on one meridian hav been plotted, the corresponding antipodal points may be plotted without furth computation: the azimuths are easily reversed mentally (or reversed azimuth valu may be pencilled in around the graduated circle), and the distances are measur inwards from the boundary instead of outwards from the centre. For example, t coordinates tabulated in the preceding section give the intersection of meridian d parallel 80°N at azimuth 358°·55 and distance 141°·25, and the antipodal point, ridian 180° and parallel 80°S, is therefore at azimuth 178°·55 and distance 38°·75. the reversed azimuths, 340°, 350°, etc., are pencilled in on the graduated circle at true azimuths, 160°, 170°, etc., then azimuth 178°·55 will be found in the position 8°·55 according to the pencilled values. The distance 141°·25 is then measured wards from the boundary of the map, instead of the supplementary distance 38°·75 ng measured outwards from the centre.

Intersections at ten degree intervals will be sufficient over most of the map, but in gions near the boundary intermediate points will be required to control the curvature the meridians and parallels. The extreme meridians are best controlled by plotting necessary extra points from computed azimuths and distances, but the amount of ditional computation need not be great. It is possible to avoid it by making use of the ation between antipodal points: that they lie 180° apart on the same great circle rough the origin.

Each complete meridian (that is, the closed curve formed by a meridian and its ti-meridian) lies partly within the central hemisphere and partly outside it; the otted points at 10-degree intervals are closer together within the central hemisphere, that that part of the curve may be more accurately drawn. If a drawing-scale is laid ross the map, so that it passes through the origin and so that the zero-mark touches y point on a meridian, then the scale-division corresponding to 180° of arc distance ll mark a point on the anti-meridian. This fact can be used to fix many intermediate ints between the plotted positions on the outer meridians, so that, even near the undary of the map, the meridians may be accurately drawn.

The same device may be used in fixing parallels. When a drawing-scale is laid oss the map, so that it passes through the origin and so that the zero-mark touches y point of a parallel, then the scale-division corresponding to 180° of arc distance ll mark a point on the antipodal parallel, that is, the parallel whose latitude has the ne numerical value but the opposite sign. Here again, the more easily drawn curves thin the central hemisphere may be used to control the curvature of the outer rallels.

Fixing the Detail

When the meridians and parallels have been drawn, the fixing of coastlines and ner detail in the central part of the map presents no difficulties. The detail required is pied from existing maps of the countries concerned, preferably from those on a ger scale, and is fitted into the meridians and parallels already drawn. Where ermediate meridians and parallels are needed to help in fixing the detail, they may computed, measured, or even sketched in by eye.

These methods, however, are quite useless in the outer regions of the map, where cessive distortion renders the shapes of countries almost unrecognizable. Here again at useful relation between antipodal points provides a simple and accurate method fixing the detail even in the region of maximum distortion. The graticule of central part of the map is plotted again on a larger scale; this auxiliary map is then rned upside down, and the meridians and parallels are re-numbered so that each rries the value antipodal to the value from which it was plotted. The detail in the gion surrounding the antipodes of the origin of the main map is then fitted into this graticule, and finally the azimuths on the graduated circle are numbered in a counter-clockwise direction from the north. The result is shown in Fig. 5, which represents the region surrounding the antipodes of Wellington.

It is now an easy matter to transfer this detail from the auxiliary map to the main map. The azimuth and distance of any point from the centre of the auxiliary map are measured; the same point is located on the main map at the same azimuth, and with the same distance measured inwards from the boundary. In fixing the coastline, points may be plotted at close intervals, say at every degree of azimuth, by this method.

SCALE COEFFICIENT

Since the equidistant azimuthal projection gives a correct representation of distances along straight lines radiating from the origin, the scale coefficient in a radial direction is therefore 1, irrespective of the position of the point.

In a direction transverse to a radius, however, the scale is distorted. An almucantar or small circle of radius σ on the map has a circumference of $2\pi\sigma$, while the circumference of the corresponding circle on the sphere (of unit radius) is $2\,\pi \sin \sigma$. The scale coefficient along the projected circle is therefore given by

$$k=\sigma \operatorname{cosec} \sigma,$$

where σ is in radians. Values of this scale coefficient (often called the 'tangential scale') for selected values of σ are shown in the following table.

σ	Scale
0°	1·000
30°	1·047
60°	1·209
90°	1·571
120°	2·418
150°	5·236
180°	∞

These values of the scale coefficient give arithmetical expression to what is clear from a glance at Fig. 3: that the representation is good within the central hemisphere, but that the distortion increases very rapidly in the outer hemisphere, becoming infinite at the boundary of the map. Because of the excessive distortion near the edges, the location of a city that is not actually plotted is not at all easy, and there is much to be gained by drawing the map in two hemispheres, the two origins being antipodal points. Such a map would have the slight disadvantage that the great circle joining two places may be in two separated pieces.

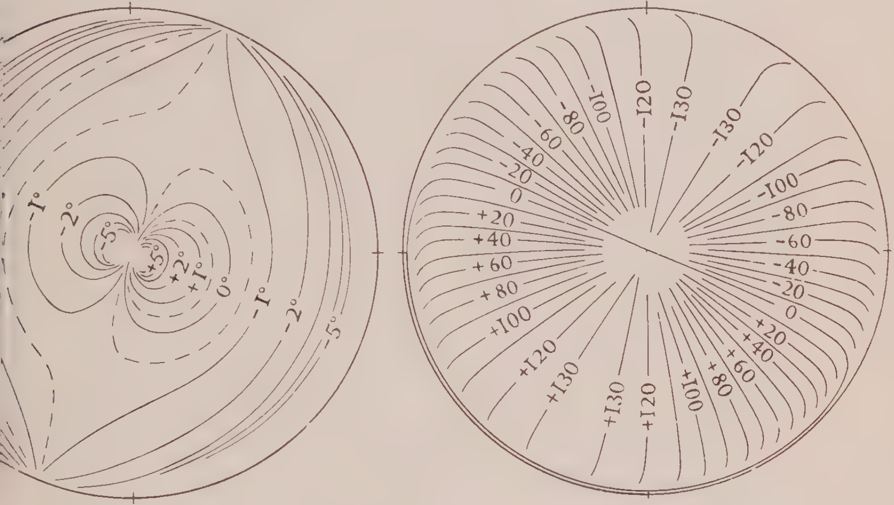
SPECIAL CASES OF THE PROJECTION

The formulae given in the earlier part of this article apply to the general case, or oblique aspect, of the projection, in which the origin may be any point on the sphere. Two special cases are worth noticing.

If the origin is a geographic pole, then $\varnothing_0=\pm 90^\circ$, and the formulae (1) and (2 take the form,

$$A=\pm\lambda, \qquad \sigma=90^\circ-\varnothing.$$

That is, the polar coordinates are now the longitude and the colatitude of the point concerned. The meridians are now equally-inclined straight lines radiating from the pole, and the parallels are equidistant concentric circles, their common centre being pole. Maps of the polar regions are almost invariably drawn on this projection, and not infrequently extended to embrace a hemisphere, more particularly for star rts. It is more rarely used for a map of the entire sphere.



6. Curves giving corrections to azimuths in degrees (*left*) and to distances in miles (*right*) to be fitted over the map shown in Fig. 3 for change of origin from Wellington to Waiouru.

If the origin is a point on the equator, then $\phi_0=0$, and the formulae (1) and (2) ome

$$\cot A=\tan \phi \operatorname{cosec} \Delta\lambda, \qquad \cos \sigma=\cos \phi \cos \Delta\lambda.$$

his form, its transverse aspect, the projection is often used for maps of the world in ispheres. Tables of polar coordinates for plotting this projection have been lished by several workers; among the best of such tables are those given by Dr. ar S. Adams in *Latitude Developments Connected with Geodesy and Cartography* ecial Publication No. 67, U.S. Coast and Geodetic Survey, Washington, 1921). his publication, the tables are headed 'Transformation from geographical to uthal coordinates—center on the equator', the azimuth being denoted by α, the spherical arc distance by ζ. The coordinates are given for every 5° of latitude longitude, and are expressed to the nearest tenth of a second. Coordinates for only quadrant of the map are given, the other three quadrants being symmetrically ed to the first.

Correction Curves for Change of Origin

The equidistant azimuthal projection represents correctly the azimuth and distance ery other point of the map from the particular point selected as origin. If azimuths distances from some other point are required, this will in general involve the pretion of a new map. But, if the new origin is not very far distant from the old one, possible to avoid the labour and expense of a second map by drawing, upon the ing map, curves of corrections to azimuth and distance so that map measurements be made applicable to some point other than the origin.

It is necessary to compute azimuths and distances from the new origin to a numbe of points on the map; the differences between these values and the values previousl computed for the first origin then give the required corrections at those points. Th points chosen should be well distributed over the map, so that smooth correctio curves may be fitted into these correction values. Fig. 6 shows, at the left, curves o correction to azimuth, and, at the right, curves of correction to distance, to be fitte over the map (Fig. 3). The map origin is Wellington, and the new origin for whic the curves are drawn is Waiouru, some 130 miles northeast of Wellington. To fin the azimuth and distance from Waiouru to any point on the map, the azimuth an distance from Wellington are first read off; the correction values at the point are als read off, and these, applied to the measurements from Wellington, give the require azimuth and distance from Waiouru.

It will be noticed that, over the greater part of the map, the corrections to azimut are very small; near the centre of the map and near the external boundary the increase very rapidly, ultimately reaching ±180°, so that in those regions the utilit of the curves fails. Similarly, the corrections to distance, although they may be large are fairly regular over most of the map; in the regions near the centre and near th boundary the curves are crowded together, and can no longer be used satisfactorily In this particular instance, the regions in which the correction curves lose their utilit are less than 10 per cent of the total area of the map.

The mathematical development of the correction curves is intricate, and need no be given here. Their nature may be made clearer, however, from a consideration of th relations between azimuths and distances measured from two points on a plane surface In that case, the azimuth correction curves constitute a system of coaxal circles, eac circle passing through the two points; the distance correction curves form a syste of confocal hyperbolas, of which the two points are the common foci. These con ditions are approximately fulfilled near the centre of the map, as can be seen fro Fig. 6. Complications arise from the facts that the two points are points on a sphere not on a plane, and that a plane projection is later made of the sphere.

RELATED PROJECTIONS

Certain other projections of the azimuthal class may be derived from the equ distant azimuthal. Normally, these projections would be computed independentl but, when the polar coordinates for plotting an equidistant azimuthal projection hav already been computed, polar coordinates for another azimuthal projection with th same origin can be obtained very simply. The azimuth of a particular point remai the same in all cases, the radial distance used in plotting varying with the type projection in accordance with the formulae in the following table.

PROJECTION	RADIAL DISTANCE
Equidistant azimuthal	σ
Orthomorphic azimuthal (stereographic) ..	$2 \tan \frac{1}{2} \sigma$
Orthembadic azimuthal ('equal-area') ..	$2 \sin \frac{1}{2} \sigma$
Orthographic	$\sin \sigma$
Gnomonic	$\tan \sigma$

THE MANIOTOTO BASIN, CENTRAL OTAGO: FROM NATURAL TO CULTURAL LANDSCAPE

MARY AITKEN

THE EARLY EXPLORERS of Central Otago were not impressed with the region. The historian of the goldfields[1] portrays it thus:

> c . . . cannot possibly conceive more than a very faint idea of the
> lute solitariness which in those days pervaded and enveloped the
> rior of Otago: the solemn loneliness of its mountains; the ineffable
> ness of its valleys; the utter dreariness of its plains. The weary traveller
> [sees] around and before him a continuous and apparently inter-
> able expanse of lofty hills—range succeeding range in monotonous
> formity, everywhere clad in a sober livery of pale brown vegetation,
> eved only by grim rocks of fantastic form, sharing the desolation
> which they contributed—backed by distant mountain peaks, which
> nded and encompassed the horizon in every direction, piercing the
> ether and clad in dazzling snows—an expanse diversified by no
> sant forests; devoid of animal as of human life; where the profound
> ness was painful in its prolonged intensity; and the only sound that
> ts the ear from dawn to dusk was the melancholy wailing of the
> d among the tussocks.'

This article traces the transformation of part of Central Otago from
ural to cultural landscape, and provides a series of pictures of the
ditions which prevailed from time to time in the Maniototo Basin.
landscape of today is better understood by study of the stages by
ch Europeans have modified the original environment. The
niototo Basin lies on the outer rim of the Otago 'plateau' and forms
upper drainage basin of the Taieri River. It is, and always has
n one of the more fertile areas of the interior, and today it stands
ontrast to the man-made desert areas in the heart of Central Otago.

The Primitive Landscape

Central Otago is an elevated plateau broken into a series of block
untains and down-warped basin plains. The massive flat-topped
ges are usually simply tilted blocks with steep scarp faces and long
tle dip slopes. These ranges strike across the country along straight
very clearly defined fault lines so that they rise sharply from the

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yke: *Early Gold Discoveries in Otago*, 1887, p. 15.

surface of the flat gravel-filled depressions. They have extremely rugged surfaces. This is due to the widespread occurrence of mica schist which has weathered into large tors of fantastic shape.

The Maniototo basin is the largest of these mountain-girt basins. The Rough Ridge forms its western wall for a distance of thirty miles. As this ridge extends northwards, its even and gently tapering crest breaks into a series of fault splinters. The Rock and Pillar Range forms the greater part of the eastern edge and is bounded on both sides by steep scarp slopes; it is thus a true horst. It is tilted towards the north-east, so that the main streams emerge on to the surface of the plain from steep gorges. Ten miles from the southernmost point of the basin these two ranges are united by the hard rock ridge of the Upper Taieri Hill, which separates the small triangular plain of the Paerau valley from the lower Maniototo plain.

The Ida and Kakanui Ranges make a fringe of greywacke on the northern side of the basin. They rise more steeply from the surface of the plain than do the southern ranges, and their smooth slopes provide a marked contrast to the rougher aspect of the schistose ridges. Further variety in rock type is found in the isolated areas of Tertiary deposits (often gold bearing) which occur around the margin of the basin and in fault angle valleys on the ranges, while near Waipiata basaltic rock forms low hills of subdued relief.

The basin floor, lying at an elevation of some 1,000 to 2,000 feet above sea level, rises more steeply towards the base of the ranges than it does in its central area. The streams radiating from the ranges have cut deep trenches through the rising basin rim; but their vertical stream banks gradually decrease in height until they merge into the flood plain of the Taieri River. Above the beds of the rivers, smooth and sloping terraces form the surface of the plain, so that there is no marked break in its generally level aspect. Thus the structural outline of the Maniototo basin is reflected in simple and massive landforms.

A Semiarid Climate

Semiaridity of climate finds expression in the peculiar desert-like weathering of the mica schist tors as well as in the extensive tussock vegetation. The clear dry air and bright sunshine attract numbers of campers and holiday makers in summer, and in winter ice skating and curling contests are held.

It is in the elevated inland basins of Central Otago that there is the nearest approach to a 'continental' climate in New Zealand. Most of the

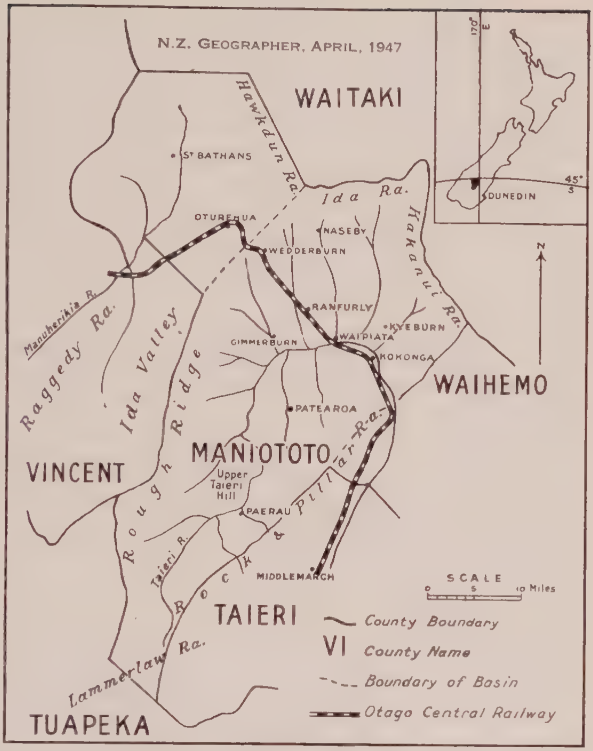

Fig. 1. Location Map.

falls during the
mer months,
en surface heat-
is at a maxi-
m. In the Mani-
to Basin over
y percent of the
ual rainfall
urs from De-
ber to March.
the hill slopes,
annual rainfall
from 20-25
nes, while on
plain it is as
le as 15-20
es. Much of the
mer rainfall
s the form of
vectional show-
resulting from
apid cooling of
g currents of warm air. Evidence of this is seen in the long lines of
ulus clouds which tower above the ranges. Often there are down-
rs of high intensity, but they are areally restricted and local. They
r mainly around the hill slopes and rarely extend far on to the
ace of the plain. The efficiency of this already low rainfall is still
her reduced by the drying effect of the northwest foehn wind and
high summer temperatures. The quick reappearance of the sun
rain also hastens the process of evaporation.

High ranges of temperature, both seasonal and daily, are charac-
tic. In summer there are long days of bright sunshine with day
peratures of over 90°F. In winter snow covers the ranges and may
lie on the basin plains as well, the average duration of the snow
r on the higher country being from 30-40 days.[2] In these elevated
nd basins night cooling of the land surface is rapid. Such conditions
ur frost: on all clear nights in winter there is frost, and also on
y clear nights in summer. It is the plain (especially its lower lying

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idson: 'The Frequency of Frost, Snow and Hail in New Zealand', *N.Z. Journ. Sci. and*
Vol. 14, No. 1, 1932, p. 53 (Fig. 6).

parts) which receives the most severe frosts. In winter the Maniototo Plain is often submerged for days under a thick layer of radiation fog. Above the fog the sky is clear, so that the hill slopes and the higher plain of the Paerau valley are relatively free from fog. The Waipiata Sanatorium has been built above the fog line on the lower slopes of the Rock and Pillar Range.

Indigenous Soils and Vegetation

The soils of Central Otago are generally fertile, but lack water. Thus the depth of the ground water level largely determines the nature of the surface vegetation. In this region of low rainfall, the upper soil layer does not appear markedly different from the subsoil, because the finer particles are not washed down by percolating water.[3] In the Maniototo Basin there are distinct differences between the soils derived from the greywacke and those derived from the mica schist especially where the latter receives adequate rainfall for plant growth. The fertility of the schistose soils is shown by the rapid recovery of vegetation from drought conditions after a light shower of rain.

All accounts of early explorers confirm the well-grassed condition of the whole of the central region. The tussock or bunch grass was the dominant grass of the formation. It was well adapted to the semi-arid condition. With its long and penetrating root system it was able to draw on reserves of moisture; its tufted form insulated it against frost action, and its thin wiry leaves withstood the force of strong winds. The tussock also gave shelter to a multitude of small plants and grasses. Indeed, the tussock appears fundamental to the growth of finer species as they rarely appear unless the tussock is established to give them protection. 'Thus the actual formation depends for its very existence on the tussock as does a forest on its tall trees.'[4]

In this grassland there were two main types of tussock, the short tussock and the tall snowgrass. When fully developed, the snowgrass was difficult to penetrate even on horseback. The boundary between the two types was fairly clearly defined, the snowgrass of the ranges merging into the shorter species on the lower land of the plain and the more open hill slopes.

The only source of wood in this vast extent of grassland was the tal scrub which grew amongst the tussock in the gullies and other favourable locations. These were plants of a xerophytic nature, such as the

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[3] R. B. Tennent and N. B. D. Marks: 'Irrigation Practice for Central Otago Conditions'. *N.Z Dept. Agric. Bull.* No. 120, 1930, p. 18.

[4] L. Cockayne: *Vegetation of New Zealand*, 1921, p. 167.

:kly matagouri (*Discaria toumatou*) and thickets of speargrass (*Aciphylla nsoi*). Even the cabbage tree (*Cordyline australis*) was absent from dry areas of Central Otago, though it appears in adjacent regions. the northeastern corner of the basin, tree manuka (*Leptospermum oides*) grew in a narrow band on the lower hill slopes, while flax *ormium tenax*) was found along the watercourses.

The luxuriant nature of the native tussock presented quite a different earance from the present day grassland. An early writer describes Maniototo country thus: 'the whole plain and surrounding hills re] closely covered with excellent native grasses showing a dull yish green with a silvery shimmer in the breeze, quite different n the pale yellow of the inferior "white" tussock, which after a years of burning and heavier stocking, was the dominant grass l before the advent of the rabbit.'[5] Descriptions such as these point change in soil moisture content due to the removal of the tussock. y also give a very clear indication that no part of the area resembled semidesert of the present day.

Over the whole of the central region, there was little variation in the ral landscape. The alternating structure of basin and range produced formity; the massive tors of mica schist made evident the dominance ne rock type; from mountain top to plain, the country was every- re enveloped in its continuous tussock covering; finally there was a eness about the climate. In this land of clear skies, there were hot mers and cold winters; there was bright sun and hard frost. Thus, unchanging aspect of each of these elements of landscape con- uted to the vast monotony of the Central Otago environment.

EARLIEST SETTLEMENT

Maoris visited this isolated region only in the summer months ird snaring and eeling expeditions. Early settlers in search of run ntry, found scrub *whares*, shaped like beehives, and roofed with ock, which were built by the natives when they came into this . Although the Maoris partook of the wild life they did little to ge the natural state of the country.

Little wonder that to the early settlers, Central Otago was not a lly attractive region. The Maniototo Basin in particular remained ted and unknown for some time after districts further inland had explored. These interior regions were relatively easy of access by es leading up the Waitaki and Clutha river valleys, which lay respectively to the north and south of the provincial nucleus of Dunedi Although several explorers must have been aware of the existence of th central area, it is not recorded who actually discovered the Maniotot Plains. A study of early literature reveals that several men believed them selves to be the first to set foot in this area. This, however, is probabl accounted for by the fact that parties could travel through the va expanse of tussock and leave little evidence of their journey.

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[5] chanan, quoted by R. V. Fulton: *Medical Practice in Otago and Southland in the Early* 1922, p. 28.

Once it had been reported that the district had good grazin possibilities, sheepmen left Dunedin to take up country. The fir stations comprised large blocks of land; their boundaries were ofte only separated by creeks and the summits of mountain ranges or othe vague physical features. Runs were stocked with small flocks c merino sheep obtained from overseas. These did particularly well o the native pasture grasses, but during the first years there was troubl with 'scab'. The station group of buildings comprised a homestea built of cob, some small huts, and the *futtah* or storehouse. Strongl constructed yards built of loose rocks housed the sheep at night, an protected them from the attacks of wild dogs which frequented th plains. It took a long time to get a station established in those day At first, runholders did not bring their women folk into this wild an uninhabited country, but left them in Dunedin. Later, stocking up an the fetching of supplies was a slow business, as everything had to b carted by bullock wagon from Waikouaiti.

The choice of routes to the region was an important matter fo runholders. Some short time after they had been up there they decide that the only possible route to the plains was via the Waihemo (or Shag Valley from Waikouaiti. It thus seems that from the very first, the earl settlers realized the importance of the natural route. Other routes tha had been used were over the Rough Ridge, and by the Taieri Rive from Dunedin. Later on, the scheme for the building of a railway wa again to bring up the question of the most suitable route to the region

GOLDMINING POPULATION

The discovery of gold in Naseby in 1863, drew a new populatio into this sparsely-settled region. A steady stream of prospectors followe the Dunstan track, the old gold road over the ranges to the diggings Some came with drays, some in wagons and many on foot carryin their packs. In this little-known inland country several miners lost thei lives in snowstorms and swirling torrents.

The mining population was an exploitive and migratory one, bu rought the people who were needed for the development of this erto uninhabited country. The new population became concen-ed in small groups centred on the pockets of the gold-bearing beds ch occurred around the margin of the basin. Naseby on the Mt. Ida lfield, was the chief of the mining centres. It rapidly grew from a astown to more solid form and to more substantial dimensions. uildings were mainly of cob and corrugated iron, which was ed inland from Palmerston South. Owing to the scarcity of fire-d, tracks were made to the tops of the ranges where peat was cut n swamps for use in the town. Coaches and main services to the gings were soon established for the benefit of the mining com-ities. The *Mount Ida Chronicle*, printed in Naseby, was almost ely a miners' newspaper, and there was little reference to agriculture s pages.

A unique feature of the settlement geography at this time, was the altitude settlements near the summits of the ranges. Chief among e were the Garibaldi and Mt. Buster diggings, the latter being at an tion of some 3,500 feet. There was difficulty in working these ns owing to the severity of the winter and to lack of water in the ner months. As these settlements were gradually abandoned, the ibution of population once again became confined to the basin .

PERMANENT OCCUPATION

fter the get-rich upheaval of the gold days, men turned to the land ake a living. In the 'seventies', many of the miners took up farming, others settled down in several branches of country business. The stations still remained, but settlers became increasingly anxious ke up land. During the mining days, gradual changes in farming od had become apparent: old ways had given place to new. On ations a small amount of cultivation had always been done. This ded the growing of oats for horses and a small patch of potatoes usehold use. Newer developments included the sowing of English re grasses and the growing of fodder crops, such as turnips and e. Wheat was widely grown in the district; but after several s of constant cropping, the original fertility of the soil soon orated and poorer yields resulted. The first heavy yields on virgin ere responsible for much enthusiasm over farming possibilities. ponsors of the Otago Central railway were confident that the t of the railway would open a vast grain-producing hinterland. vision of holdings (into blocks which later proved too small as economic units on account of the dry season risk) was a commo mistake arising from the mistaken promise of this new found fertility

During its development before the coming of the railway, th Maniototo district had to be largely self-supporting. There were tw creameries in the district to which people took their cream to be mad into butter. Wheat was taken to the flour mill at Naseby. Often took farmers a whole day's journey to travel a few miles, and then the waited until the flour was ground before making the return trip Although this self-contained way of life gives a pleasing picture of th Maniototo economy in the pioneer stage there is a less attractive sid to conditions at this time.

In the early seventies the rabbit had spread throughout the centra region. Before the arrival of the rabbit pest the eminent botanis Petrie,[6] had already noted the deteriorated stage of the pasture owing t overgrazing by sheep and the too-frequent burning of the tussock It had early been discovered that sheep preferred the new green shoot which appeared after a fire, to the longer and coarser growth of th tussock. Repeated burning, often at the wrong time of the yea destroyed not only the tussock but also the finer species of nativ grasses. The spread of the rabbit through Central Otago caused furthe deterioration, and the country was literally 'eaten out' by millions c rabbits. The rabbit industry became a flourishing business. At firs rabbits were valued for their skins alone, but later their carcases wer frozen for export. The menace of rabbits to pastures persisted, an pastures had to bear the strain of the rabbit pest as well as grazing b sheep and attack by fire. The result was a steady fall in carrying capacity

THE RAILWAY

The question of building a railway called for a decision on one of th three projected routes to the basin. The inhabitants of Palmersto South pointed out that the Waihemo route was 'the proper and mo natural route'[7] to the Maniototo Basin (as indeed it was). This clai however was overcome by the great political pull for the Taieri Gorg route which proceeded by way of the lower Taieri plains from the cit of Dunedin. The route chosen was somewhat unfortunate as th Maniototo Basin's agricultural and economic ties were closer wit North Otago than with the farming lands around Dunedin. The rout of the rail was also a contributary cause of the decline of Palmersto th, which could served as a way junction rting Otago ic either north south as re- ed.

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[6] D. Petrie: 'Report on the Grass Denuded Lands of Central Otago'. *N.Z. Dept. Agric. Ind. a Comm. Bull.* 23, (N.S.), 1912.

[7] *Otago Daily Times*, Jan. 4th, 1877, p. 3.

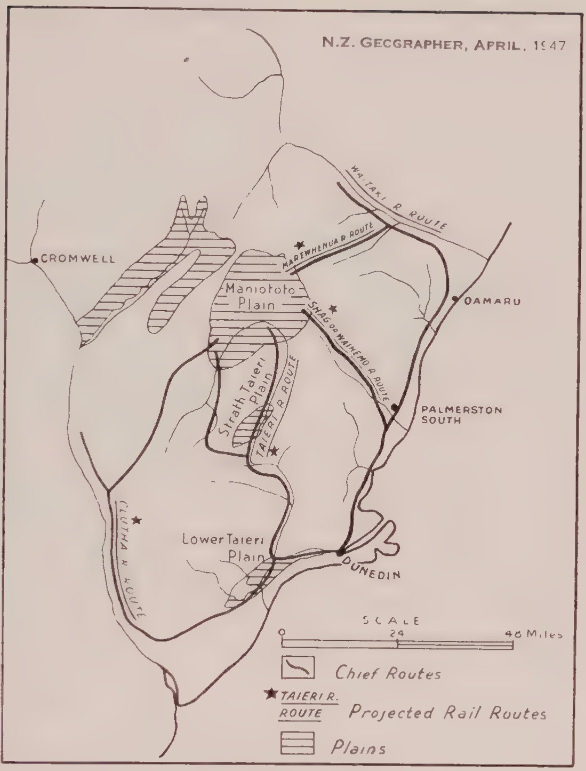


Fig. 2. Chief routes to the Maniototo Basin.

The building of railway was the st important gle event in ging the ap- rance of the tral Otago scape. With the er transporta- of building erial, the new tral Otago e was now a oden frame ture typical of rest of New and. The railway also made timber available for fencing: before slabs of schist rock had been used as fencing supports. The im- ation of heavy machinery for gold dredging was also made easier the introduction of rail transport.

lthough the Central Otago railway did not accomplish all its mpions claimed it would, it did bring about incidental changes. nges in land use gradually became apparent. Chief of these was the nuous decline in wheat growing. The Maniototo Plains never me the granary some expected. Two factors were responsible: ropping (which ensured loss of soil fertility) and the importation ail of outside flour. The old mill at Naseby shifted to Ranfurly, ater closed down. The railway made possible closer settlement of some distance from the track: the settlement of the Paerau valley place early in the century and subdivision after the First World brought closer settlement to the central portion of the plain.

regrouping of population also followed the coming of the railway. by the old centre gradually declined and gave place to Ranfurly

Fig. 3. Looking across the Rock and Pillar Range to the Rough Ridge across the central area of the basin.

Photo: Public Works Departmen

which grew rapidly by reason of its position on the line and its central location in the plain. Naseby lost importance as a business and administrative centre and many of its public buildings were pulled down and moved to Ranfurly.

The Contemporary Scene

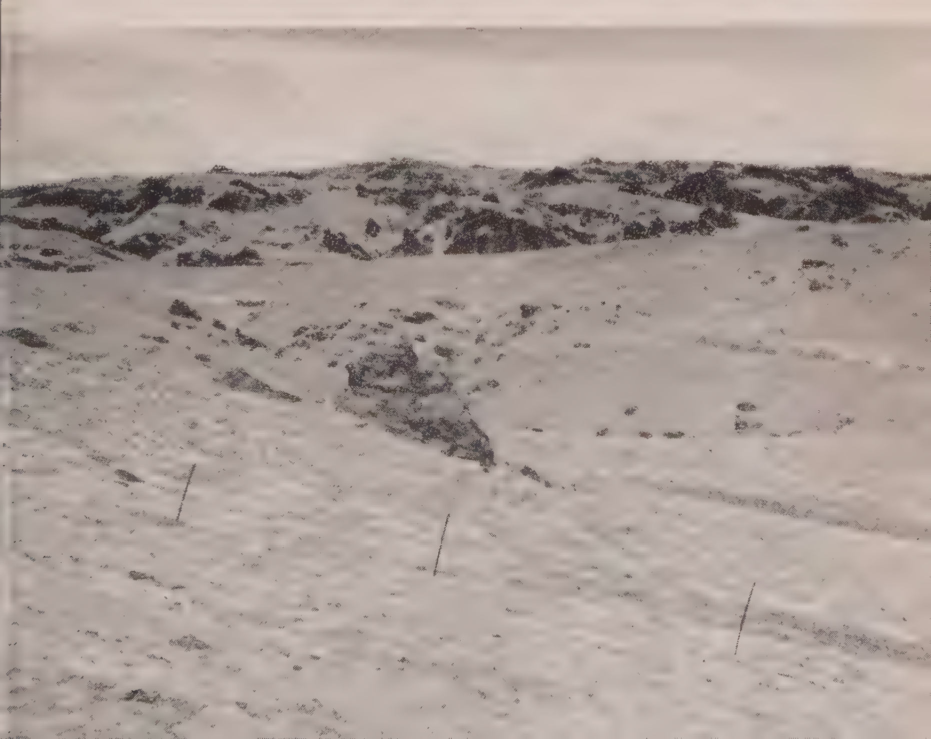
The contemporary landscape of the Maniototo Basin stands in sharp contrast to that described by the first explorers who penetrated inland from the coast. Throughout, the ever-changing pattern of land use has been closely influenced by the natural outlines of the basin. Today there are two major land use regions. There is an area of tussock grass pasture on the hill country together with variegated tracts of cultivation on the basin floor.

For nearly a hundred years the pasture on the ranges has been continuously used for the grazing of sheep. Over all the hill country the luxuriant nature of the vegetation has greatly deteriorated: it has been attacked by constant grazing and repeated burning so that over wide areas, the tussock cover has now disappeared and the topsoil is left exposed to the direct attack of the elements. It is the lower hill slopes which have suffered most seriously from soil erosion. They have n used for the wintering of large numbers of sheep because they are rmer than areas surrounding them. These lower slopes have also ried the burden of a high rabbit population and the surface of the ound throughout is pitted with countless rabbit holes, and in places topsoil so loosened has long since been carried away by strong winds.

Once the tussock disappears from these areas its place is taken by lling scabs of *Raoulia* spp. The lower hill slopes from Waipiata to the per Taieri Hill are covered with scabweed and are exceptionally rren in appearance: in some places active gullying is apparent. The nd cushion-like plants form a protective ground covering which ves as a seed bed in which other plants may make a start. If there is vement towards recovery, these mats are pierced by wisps of tussock. urther deterioration is taking place the soil between the plants is ured by surface run-off. Once this happens it is not long before remaining small earth pillars, capped by the surviving scabweeds are uced in size and finally worn away.

The morphological differences between the northern and southern ges have been accentuated by soil erosion. From summit to foot smooth slopes of the greywacke ranges are scarred by the trails ong gravel slides. When these slides break away they rapidly spread wn hill and overwhelm vegetation growing in their path. Once they

4. The summits of the ranges still retain their tussock cover, but on the lower hill slopes ussock has vanished and its place is taken by protective mats of scabweed.
Photo: Soil Conservation and Rivers Control Council.



have developed strong winds seem to be an important factor in the secondary movement of slides. Miners notice that after windy weather water races are filled by migrating shingle. Also after rain large angular blocks of detritus may be seen crashing down the gullies. How different under natural conditions when on the well-vegetated slopes the water from snowmelt and rainfall percolated slowly through the soil so that streams were of a clearness unknown today.

In spite of soil erosion on the ranges, the native grasses still form the basic constituent of the vegetation cover. Surface sowing of English pasture grasses on hill slopes has not been widespread. Several factors discourage this practice: the establishment of exotic grasses would require the eradication of the rabbit pest, for the rabbit would select the softer introduced species in preference to the hardier native types; and the hardier native grasses soon replace the introduced species under the severe climatic conditions. There has, however, been a partial advance of grasses and weeds into the surrounding tussock vegetation. This movement is especially noticeable on slopes facing northwest and which are adjacent to ploughed paddocks. There is also little doubt that a system which aimed at definite eradication of the rabbit pest would do more to improve tussock pastures than the system of piecemeal control which exists at present.

Land Use on the Plains

It is on the plains that human occupance has brought the greatest changes in the appearance of the landscape. Here the pattern of land use involves a variety of colour which contrasts with the uniform yellow-brown mantle of tussock on the encircling hills. The rectangular pattern of pasture and crops is interrupted at varying intervals by lines of shelter trees, and by farm houses which are linked with the widely spaced townships by a network of gravel roads.

Between the Rock and Pillar Range and the Rough Ridge there is a marked similarity in the pattern of land use. A profile of land use drawn from one of these ranges to the other would first include the tussock grazing of the hill country and then cut across the rectangular blocks of cultivated pasture and cropland which border the river flat of the Taieri, the swamps of which form a continuous strip of grazing for beef cattle. On the opposite side of the river the pattern is repeated. Where smooth slopes occur locally, the rectangular pattern continues above the general level of cultivation. In the White Sow Valley the upper limit of cultivation is about 2,000 feet. This hill ploughing of paddocks represents possibly the most elevated expanse of cultivated land in New Zealand.

In the northeastern corner of the basin the symmetrical pattern of land use is broken by extensive areas of stunted tussock vegetation which occur on the dry soils in the Kyeburn district and also along the base of the Kakanui and Ida Ranges. Other areas of deteriorated grassland occur around the margin of the basin and are occupied by grasses of little food value. At the foot of the Ida Range near Naseby there is the 4,000 acre plantation of (mainly) *Pinus radiata.* Apart from these extensive plantations trees have only been grown around homestead settlements. The provision of shelter for stock has not been a widespread practice, and even today there are wide stretches of treeless country with few signs of human habitation so that this central country still retains the appearance of vast unfilled spaces.

FARM ECONOMIES

On the higher and colder country of the northern ranges the type of farm closely resembles that of the wool-producing high country further inland. Most of the land here is over 1,800 feet. There is little cultivation and little growing of winter feed. This deficiency, however, is overcome by keeping down the numbers of stock carried and thereby allowing a greater growth of pasture. This practice provides a safe margin of feed in a severe season. Merino sheep are dominant, since the hardy constitution of this breed enables it to thrive on this rough type of country. Holdings are larger than the average for the basin. Sheep losses are often high and may be exceptional in seasons of heavy snowfall.

Most farms on the plain include a block of hill country and adjoining flat land. Production from this type of farm consists of wool, store stock and a few fat lambs, and on this account the halfbred is the main type of sheep carried. The growing of auxiliary fodder for stock in the cold winter months is an important and necessary practice. Areas of clover and lucerne hay and root crops, chiefly turnips, are cultivated for this purpose as well as for fattening. A small area is usually devoted to the growing of grain crops, mainly oats, as well as wheat, barley or peas.

The 'mixed' farm includes the flat land on the basin floor other than that forming part of the grazing runs. On this type of farm fat lambs and cropping are more important than wool production. This is reflected in the types of sheep; Romney and Southdown crosses are the breeds favoured, the latter predominating on the heavier and irrigated land. Winter feed is not so important on these farms because ewes and lambs are sold off before the winter months, and arrangements are often made with hill country farmers to winter stock on blocks of upland country. Many of these 'mixed' farms rely on irrigation either from privately operated schemes or from the government water race which carries water from the Manuerihikia valley. The chief effect of irrigation in the Maniototo Basin has been to raise the carrying capacity of the land; by its use farmers are enabled to take on additional lambs for fattening. Irrigation has thus not yet resulted in any marked change in land use.

SETTLEMENT

In Central Otago population is confined to the flat land of the valley floors. Along the junction of hills and plains country there is a marked line of peripheral settlement. It is extremely well defined along the base of the Rough Ridge and the Rock and Pillar Range. This linear arrangement of homesteads dates from the days when the early runholders built their homes around the margin of the basin. A situation at the foot of the hill slopes was favoured for the sites of homesteads because it is the most pleasant for a farm house and because the slopes were warmer than the lower-lying land of the centre of the plain. Here also there was a good water supply from streams off the hills, and the farm buildings are in a position which is convenient for the working of both hill and flat country. This linear grouping of population is only related to agricultural settlement; it is not associated in any way with the rise of the gold towns. It is a pattern of distribution which expresses the close relationship existing between natural features of the landscape and the practices and requirements of a certain type of farm economy.

Fig. 5. Stone-walled enclosures

Fig. 6. An old gaol built of schist slabs.

Along the base of the northern ranges, homesteads are more widely scattered owing to the larger size of holdings on this colder and higher country. The central portions of the plains remained practically without population right up to the close of the goldmining period. With the demand for land for settlement, and subdivision of the large estates, and later with the coming of the railway, population spread into the central area where there is some of the best farming land of the region.

The successive stages of human settlement and accompanying improvements in transport are reflected in the striking variations in house types found in the Maniototo. The earliest houses were those built of cob and stone; these were the only building material available to the early settlers. Today such houses are still favoured; and Central Otago stands out as one of those regions in New Zealand which have a large number of cob houses. Many of the early structures have been extremely well preserved in the dry climate of the interior and are now often roughcast on the outside to give a modern finish. During the gold days the scarcity of building material was further illustrated by the erection of houses of corrugated iron which was easier to cart inland than timber by wagon transport. With the coming of the railway the wooden house was introduced, but many people still preferred the more solid cob dwellings. Of recent years houses have been built of brick which like the cob or sun-dried brick house is better suited to withstand the quick changes of temperature than the lighter wooden type of house. Owing to the cost of transport the distribution of wooden and brick houses is usually limited to land near the railway line.

Townships are found along the railway line and on the sites of former gold workings. There are marked differences between the old gold and wagon centres such as Naseby and Patearoa and the railway settlements of Ranfurly and Waipiata. The newer settlements are distinguished by the number of their wooden and brick buildings and

Fig. 7. Cob building and fence.

Fig. 8. A modern type of house.

recent plantings of *Pinus radiata*. From a distance the old mining towns may be recognized by long lines of tall trees, mainly poplar. Today Naseby is but a shadow of the town it formerly was. Empty sections with picket fences and overgrown hedges show the site of former houses. There are tumbledown abandoned houses with a tangle of domestic plants and fruit trees. Some of the streets are now covered with grass and animals graze in and out of the town area. The hills around the town are covered with broom originally planted for shelter by the early miners. A wide area of the diggings is now waste land covered by tailings from the mining claims. In the vicinity of Naseby the spread of the larch across the diggings from plantations above the township is a striking feature and offers some hope of natural reclamation of the former goldfields.

For many years irrigation schemes have been considered for the dry areas of Central Otago. Several factors, however, have operated against the development of large scale irrigation. The distribution of water is a major difficulty because the main rivers are deeply entrenched below the level of the plains, so that the use of their water for irrigation entails the construction of dams far upstream and the digging of long water races. Also the land served by each scheme is limited to the flat area of the valley floors. The projected scheme for the irrigation of the Maniototo Plains is based upon the damming of the Taieri River and the formation of a lake some eleven miles long and three miles wide in its upper valley which is in an area now in farms. If developed this scheme would irrigate some 85,000 acres.

CONCLUSION

Central Otago still retains something of its original monotonous character. This monotony is not so complete as it formerly was for settlement has created a diversity in the vegetation cover which was absent when the indigenous tussock covered the whole area. With the greater use of irrigation and as barren areas are transformed into green and flourishing farm lands its character will be further modified. Closer settlement with greater reliance on the use of hydroelectricity and the planting of shelter belts would be necessary accompaniments of such spectacular changes in land use. It seems likely that the future development of Central Otago will involve greater changes in the landscape and so further tend to destroy the once all-pervading monotony of the Maniototo region.

SOME FEATURES OF NEW ZEALAND'S RACIAL PROBLEM[1]

RONALD L. MEEK

IF YOU get off a ship at Balboa, in Panama, and walk into the nearest shed on the wharf, it is very probable that you will see facing you two doors. On one door you will see the words 'White Women', and on the other, 'Coloured Women'. When you have seen these doors, you will be prepared for what you will see in the city itself: families of coloured people living in basement rooms in slums and in the most horrible poverty and squalor. I feel however that it would be better to discuss the situation in our own country rather than that in any other land, since in New Zealand we still have the opportunity of preventing our racial problems from becoming as serious as they have become in the United States. I feel also that the problem is more complex in the Dominion where the manifestations of racial discrimination and its innermost causes are more subtle and more difficult to lay bare.

It has been suggested that complacency is one of the most prominent characteristics of New Zealanders. We may classify the various brands of complacency on racial questions into four groups: there are those who deny that a problem exists or is likely to exist; those who recognise vaguely that a problem exists, but who are unwilling to do anything about it; those who find out from the Year Book that ninety percent of the people in this country are Europeans and wonder what the problem is; and lastly those who believe, consciously or unconsciously, in the cultural and intellectual supremacy of what they call the 'white', or 'British', race. The manifestations of this last outlook are often very difficult to isolate, and therefore these are the most dangerous.

The presence of a welter of races within one national boundary does not necessarily mean that conflict is inevitable, but race may be a factor contributing to turmoil and strife. New Zealand already has a considerable and fast-growing native minority and we are by no means inoculated against the racial disease. It is true that we do not exclude our natives from the trams, but we do keep them out of certain hotels and boardinghouses, and in effect deny them secondary education.

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[1] This article is a condensation of a lecture given to the Wellington Branch of the New Zealand Geographical Society on 10th April, 1946. In the absence in England of the author, the condensation has been made editorially, and the author has not had the opportunity of reading the proofs.—*Editor's note.*

One person in every ten in the North Island of New Zealand is a member of the Maori race. Our complacent New Zealander may one day find that the proportions are much less comfortable. The natural increase rates of the Maori people are at least three times as great as the comparable rates for the European population. In the ten years 1926-1936 the Maori people increased by twenty-two percent and the European population by only six percent. It is obvious from a brief glance at the age constitutions of the two populations that the present tendency is likely to continue at least for some time. With the possible exception of Chinese and Indians the Maori people have the largest rate of natural increase in the world.

Until the detailed reports of the 1945 census are published there will be no reliable racial statistics for New Zealand (other than for the Maori people) of later date than 1936; but there have probably been few changes since then other than those due to natural increase (except in the case of the Jewish population, which has been quite considerably increased by immigration). In 1936, then, there were 82,000 Maoris,[2] being 5·23 percent of the population, and 6,976 race aliens, being 0·44 percent of the population. Of the 6,976 race aliens, about six thousand were Asiatics, and the rest mainly Polynesians. There were about three thousand Chinese, one thousand Syrians, and a thousand Indians. (There were also one African pygmy and 102 Japanese.) In 1936 there were approximately 2,500 Jews, but there are now probably something like four thousand.

The Maori people give rise to the greatest of our racial problems. There are 97,263 Maoris in New Zealand; 94,488 of them live in the North Island. The exceedingly high birthrate has shown no signs of decreasing during the last ten years. Between 1926 and 1936, the proportion of Maoris of full blood dropped from 71 percent to 68 percent, which was probably not a significant fall. During the same period, Maoris of full blood increased by 23 percent and those of part Maori blood by 57 percent.

In 1936 about seventy percent of the Maori people were dependants, pensioners, etc. The rest was made up of twenty-three percent engaged in primary production, only five percent in industry, and one percent in other occupations. In 1936 it could be said with confidence that when the Maori was not an agricultural labourer, he was generally an unskilled labourer. Since 1936, however, the position has undoubtedly changed considerably—to what extent only detailed reports on the recent census will show—but the proportion engaged in industry is now very much greater.[3] The figures showing the geographical distribution of the Maori people disclose a drift to the cities of two thousand between 1926 and 1936. The drift during the last ten years has undoubtedly been much larger—it was recently estimated that two thousand Maoris are working in industry in Auckland alone. As the young men are unable to find employment on the land, they will come to the cities.

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[2] In 1945 preliminary census figures show a Maori population of 97,263 (excluding those in the armed forces overseas) representing an intercensal percentage increase of 18·7 compared with 8·2 percent for total population.—*Editor's note.*

These statistics give us some idea of the numbers and distribution and occupations of the Maori people, but they give us no real idea of the *condition* of the people. For that purpose a few statistics like the following are necessary to put us on the right track. Taking the deathrate first, New Zealand as a whole, (including the Maori people) has nearly the lowest deathrate in the world. The Maori people, however, has a deathrate which is so high that there are only two or three countries in the whole world which possess a higher one. New Zealand as a whole also has one of the lowest deathrates from tubercular diseases in the world. The Maori rate is about twice as high as that of any other country which publishes statistics. Again, New Zealand has the lowest infant mortality rate of any country in the world. The Maori people were, however, in 1938 only four from the bottom of the list. (The position has improved somewhat since then, but there is no evidence as yet of a longterm trend for the better.)

Seeing these things, a great number of people excuse themselves from taking any action to make things better by ascribing all the worst characteristics and susceptibilities of the modern Maori to innate racial tendencies. We hear it every day in some form or other—the Maori is 'naturally' improvident, 'naturally' susceptible to certain diseases, 'naturally' incompetent as a worker, and so on.

Insofar as the Maori today *does* possess such characteristics—and they are commonly so greatly exaggerated as to become mere caricatures of the real habits of the Maori people—we must remember that he did not always possess them. There is always a danger, of course, of romanticising the early life of the Maori in this country, before the coming of the white man, just as there is an even graver danger of romanticising their condition today in a Dickensian fashion. But from all

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Preliminary figures indicate that while the overall increase in Maori population totalled 18·7 percent, the increase in Maoris resident in the Auckland Urban area exceeded 244 percent. —*Editor's note.*

accounts, there appears to be no doubt that before the coming of the white man, the Maori people possessed a developed government, a rather fine philosophy and religion, a proud art, and a sense of community which is so rare today that we find it difficult to understand. He possessed an exhilarating and not too dangerous pastime in the tribal wars; he lived in perfect health in clean and sanitary living quarters; his was, in fact, a flourishing and beautiful race. And all this, too, without the aid of policemen or slave-drivers or real exploitation. Quite obviously, such habits as the white man now complains of arose only after the coming of the European. And, just as there is no Jewish problem but only a gentile problem, so there is really no Maori problem, but only a *pakeha* problem.

It was not so much the objective things which the white man brought—the firearms, the drink, the diseases, the bad food, the vices—that were of the most immediate importance, but the more intangible effects of those objective things. The loss of *mana*, and the loss of the land on which that *mana* was based, were the things which laid the Maori low. Let us not think that the conflict between black and white in New Zealand in the early days was any better or any worse than the similar conflicts in every other country where an 'advanced' people has taken over from a relatively primitive one. The Maori wars were not less sordid than any other comparable wars, which is, of course, the reason why they are made to shine with such lustre in our school textbooks. The Maori *tapu* was impudently disregarded by missionaries and settlers; and attempt was made to replace the 'beastly communism' of the Maori by the white man's enlightened individualism; competition began to replace co-operation.

The Maori was at first able to take advantage of the valuable elements in European culture. The part he played in opening up the country for the white men, and in the early coastal trade, is not generally appreciated. But the Maori wars came, and with them the loss of the land and the *mana* and many of the finest of the warriors; the cry of 'europeanise the Maori' was heard everywhere in the land, and just before the turn of the century the fortunes of the Maori people were at a hideously low ebb. Their survival and recovery, let it be emphasised, has been due not primarily to the efforts of the *pakeha*, but to those of the Maori people. The qualities for which we blame them today are of our own making. It is up to us to help the Maori leaders to overcome the difficulties we have caused.

Today the picture is different. No longer do people croak, as they did in 1899, that the Maori race is doomed. The boot is now on the other foot, and people talk (equally wildly) of the coming doom of the white race. The number and strength of Maori organisations has increased to an amazing extent. The Maori *mana* has been reborn. But at the same time, progress is hindered by a sort of vicious circle. Some Maoris, when judged by *pakeha* standards, appear improvident and apathetic; we forget that such instances are exceptional, and at any rate of our own making, and tend to stigmatise the whole Maori race; we therefore tend to force the Maori race into occupations and environments which may turn the imaginary bad qualities into real ones. For example, I was once told by a landlady in Wellington that she would never take a Maori girl as a boarder in her house, because 'if I did all the other tenants would leave'. This attitude is very common among landladies in 'better class' districts, so that Maori girls coming to the city are forced to live in very poor districts where they stand a good chance of developing those very vices of which they have hitherto been unjustly accused. Give a dog a bad name, and the dog will soon deserve it.

Foremost among native problems is that of housing. At least a half of the Maori people are inadequately housed. The 1936 census showed that the average number of Maori people per dwelling was about six; more than half the people lived in dwellings consisting of three rooms or less; and approximately a fifth lived in one room only. And even though in some cases the 'one room' might be a very large one, the position is almost as bad as it could possibly be. In the cities, particularly, the operation of the colour bar forces Maoris to live in the most unwholesome localities. The worst districts in the slums of Auckland are largely occupied by Maoris, and the position is rapidly becoming very bad indeed in Wellington. For example, a Maori Welfare Officer interviewed 250 Maori women living in Wellington. She found that of their accommodation only 18 percent could be classified as 'good'; 30 percent was 'fair'; 20 percent was 'inferior'; and 32 percent was 'very bad'. The officer defined the 'very bad' cases as 'overcrowded accommodation in slum areas in proximity to hotels, and bad environment resulting from employment in licensed hotels, inferior types of restaurants, and houses of ill-fame'. Among a number of heart-breaking examples given by the Welfare Officer of the conditions in which her people were living, the following case may be quoted not because it is exceptional, but because it is merely illustrative:

'*Case Number* 4. *Rugby Street*: this is an example of housing conditions. These people are very Maori, and had the Welfare Officer not been of Maori blood admission on to the premises would have been virtually impossible.

The accommodation consists of one main room, 12 ft. by 16 ft. approximately, with a small room used exclusively for a crippled child of the family.

The rental is £1 17s. 6d. per week, furnished with two single beds, a table, and other bare necessities. It is used for sleeping, eating, and for all purposes. When we arrived the children were washing the dishes in a saucepan. The occupants of this room consist of: father, mother, married daughter with child of two years, three children, and crippled son. With the exception of the crippled son, all sleep in the one room with the aid of a mattress on the floor. One of the children at present is down with measles.

The people are under the impression that on account of their being Maoris, and of the number of children, their chance of obtaining decent accommodation is very remote. They can afford to pay a reasonable rental for decent accommodation.'

That is what the colour bar means in New Zealand. It would be a pleasant, if sadistic, occupation to take all landladies who refuse to 'lower the tone' of their houses by letting rooms to Maori girls on a tour of inspection of the horrible living conditions in which they and their kind have forced the Maori people to live. One of the most wholesome pieces of legislation which could be placed on the statute book would be an act preventing landlords (and landladies) from refusing to let rooms to Maori people just because they are Maori people, the onus of proof to be on the person who refuses to let the room, and not on the Maori.

The report of the Welfare Officer from which I have just quoted, mentions the difficulties which the Maori encounters on coming to the cities because of his relative lack of education. The *native* primary schools teach only about half the Maori children; in some scattered districts there is no native school near enough, and in other districts historical reasons are to blame. Secondary education is only available in exceptional cases, largely because of geographical and financial difficulties, but also because the academic nature of the courses provided both in the ordinary secondary schools and in the denominational native schools does not appeal to the Maori. There is a dangerous gap between the day when the Maori child's primary education finishes and the day when he gets his first job—a gap during which a great deal of the good work done in the native schools may be undone by the home environment. But probably the greatest deterrent to the Maori is that which was expressed by Mr. K. T. Harawira at a meeting of the Auckland Vocational Guidance Advisory Council in November 1945: he was reported as saying that 'there was at present an awakening among the Maoris as to the value of education, but their home conditions very often retarded the training of the young people, and often they lacked the opportunity to take up a career. There was a feeling among a great percentage of Maori youth that there was no point in proceeding with study, as when the choice had to be made between a Maori and a *pakeha* of the same qualifications for a position, the *pakeha* usually received preference.'

What, then, is to be done? The problem cannot be solved merely by asking for 'goodwill' and making fine speeches; its solution is not assisted by dragging the Maoris out as if they were museum specimens for the delight and edification of foreign tourists. A people can remain neither noble nor great if it continues to live in housing conditions such as those I have described, or if its infant mortality rate remains almost the highest in the world.

The concrete measures which must be taken if the problems are to be satisfactorily solved include the following: arts and crafts; the preservation of the language and its introduction into primary education; the encouragement of all community activities of the people; the institution of *maraes* in the city; the encouragement of development schemes, with an investigation of the possibilities of collective farming; great and immediate improvements in health facilities and propaganda; facilities for the technical education of the Maoris in the city and in the country; provision for granting loans for housing to Maoris who have no security, and the provision of secondary schools in the less scattered areas. There are a hundred other measures which suggest themselves as soon as we become aware of the real facts of the situation.

But these improvements must not be presented to the Maori people on a platter, as the result of earnest representations made entirely by good-hearted *pakehas*. That might be a very grave error indeed. The best elements among the Maori people themselves must be mobilised to fight for such improvements. The basic policy of progressive individuals and institutions towards the Maori people should not be either to encourage them to merge entirely with the European community, or to force them into a community entirely apart; it should be to develop the initiative and intelligence of the Maori people themselves towards steering a course between these two extremes, to preserve their culture and the good aspects of the Maori way of life, to draw them into progressive movements, and to prove to them by taking up their day to day problems that their interests are identical with those of the progressive European working-class movement.

GEOGRAPHY AND SOCIAL STUDIES

J. L. HEWLAND

IT IS NOW three years since the publication of the Thomas Report, and the subsequent reorganisation of the postprimary school syllabus. Teachers in most postprimary schools have had two school years in which to experiment in accordance with the recommendations of that report. Although two years may be considered to be insufficient time in which to reach definite conclusions, certain repercussions of the new curriculum on the teaching of geography in particular, have already become evident to those of us who are actively concerned with it from day to day in the classroom.

The inclusion of the new title, 'Social Studies', in the curriculum may be taken as a suggestion by the authorities that geography—and perhaps history—were being wrongly taught: it was apparently inserted in an endeavour to correct such wrong teaching, and from this point of view all progressive teachers have welcomed it. Both history and geography teaching were sometimes dominated by textbooks which were chosen often for their low cost rather than for their content: once chosen, they were allowed to become masters rather than to be employed as servants. Geography textbooks were unfortunately too often an assembly and mixture of topics ranging from geology to overseas trade statistics; a variety of material was presented from the uncritical point of view that man's activities are decided for him by his natural environment, regardless of his ethnology, traditions, culture, economic system, or technical and scientific ability. Nearly all these texts contained maps with lines which quite arbitrarily divided an area into 'regions', and proceeded to describe the 'relief, climate, and products' of each of these regions in turn, as though they existed independently, and as isolated pieces of the earth. Wendell Wilkie has given us a phrase, 'One World', which expresses the falsity of this method and procedure. These regions were more often than not called 'natural regions'. In the absence of any definition, the Canterbury Plains might be classed as a 'natural' region of New Zealand in spite of the fact that its natural characteristics have been transformed and that almost the last of the virgin tussock was ploughed in as much as sixty years ago. Few of these textbooks gave to the pupil forced to read them, any real idea of what portions of the earth's surface actually look like; they had to be able to reproduce a map as a representation of it, but were provided with no technique for describing it as they would describe their own home district to, say, an overseas pen-friend.[1]

As a method of indicating that perhaps the wrong kind of geography and history were being taught, the use of the term 'Social Studies' must be welcomed; and if objection to the introduction of this title implies a return to an aimless mixture of 'natural regions', elementary geomorphology, export and import figures, the physics of the atmosphere and oceans, or map projections, then it cannot be admitted as objection worthy of serious consideration. There may also appear to be some justification, on occasions, for grouping subjects such as geography, history, and perhaps economics, under some such general heading as 'the Social Studies', just as we speak of 'Modern Languages' or 'the Sciences'. It is however open to doubt whether the desire to improve the teaching of geography can best be attained by attempting a fusion with history and the creation of a third, and hybrid, subject which can only find a place on the timetable at the expense of either history or geography, or both.

History and Geography

Two years' experience of 'social studies' in the classroom has been sufficient to suggest in many quarters that in New Zealand the attempted fusion of geography and history is, as in the United States, leading to confusion of aim.[2] It is in the *method* rather than the aim of improving geography teaching that the new syllabus is open to criticism. Teachers of geography in the University have from the beginning made this abundantly clear.

> 'Let us admit at once the fundamental goodness of the general aim—the better understanding of society—in the expectation that this better understanding will lead to better and more rational behaviour of its members. . . . . . If any advice from me might be worth anything, it is only this—teach history with more geography, and

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[1] The writer often tests his teaching of geography by asking the class to express on paper their first thought when he says, for example, 'London'. Whenever a pupil draws a map of the Thames Estuary inserting a dot for London, it is obvious that the geography of London has not been effectively taught. The remedy lies in a greater use of pictorial aids and vivid descriptions.

[2] This is exemplified in the School Certificate Examination history and geography papers for Nov. 1946, the first to be set under the new regulations and therefore to be closely examined as an official interpretation of the new prescriptions. These two papers contain questions almost identical in form with each other in asking for certain places to be marked on maps. For example in the history paper the candidate is asked to mark a hydroelectric power station on a map of New Zealand; in geography, a coalfield. Again, the history paper includes a request for reasons for the low standard of living in China or India, while one geography question asks for a discussion of the pressure of population in Southeast Asia (both, incidentally, highly complex and controversial problems, approached with much trepidation by research scholars).

> teach geography with more history, but do not let the two subjects lose their identity as such . . . . . If enthusiasm for something new leads you to "merge" history and geography in the schools into something "social", I feel equally sure that you will soon come to wonder where you are going.'[3]

And again more recently:

> 'Dissatisfied with the sort of geography taught for many years in New Zealand schools—especially that heavily weighted on the physical and mathematical sides—yet unaware of, or unfamiliar with the historical concept of the subject, the authorities have seen fit to introduce a new subject which they have labelled "social studies". This move was anticipated a number of years ago in some parts of the United States. There its story was rather a sad one, and is happily largely at an end . . . . . It became clear that to attempt to produce a reasonable synthesis of [the] . . . . . points of view [of history and geography], is to attack a virtually impossible task—one which, according to Ellsworth Huntington (whose experience in the two disciplines is as wide as that of any man), makes "thinkers pause where elementary school teachers plunge without fear". . . . . In New Zealand the Thomas Report makes an almost impossible demand on our secondary school teachers and their pupils in requiring them to make a fusion of these and other subjects under the heading "social studies". . . . . . I fully agree with the primary aim of "social studies" if it is to furnish a better understanding of society everywhere and to provide a basis for the more rational behaviour of its members . . . . . I feel confident that this most admirable objective could have been attained by requiring the teaching—at a level suited to school purposes—of the regional geography I have attempted to describe here, and which seeks simply to discover and understand "what places are like", together with a broad "period history", preserving above all the essential identity of each. If we must have something more "social" the emphasis could well be given to the cultural aspects of geography and the social phases of history, without omitting or completely neglecting other sides of the two disciplines to the risk of their distinctive points of view . . . . .
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> Geography must inevitably consider those historical, traditional and other cultural factors of areas which come out of past periods, for they make potent contributions to the character of the "place" . . . . . Geography without history is but a list of names of places and physical features . . . . . History and geography are adequate. They must go side by side, but they need not be amalgamated. Nor may they be merged without destroying their value and identity'.[4]

The danger which has arisen then is that the aim of the 'social studies' course, good as that aim is, is being made more difficult of achievement by the method adopted—the method of introducing a third subject which is neither 'good' history nor 'good' geography. We can of course select any one time in the past and study the geography of an area at that particular time: that is an historical geography. Or we can study the geography of an area in successive years and have a sequence of historical geographies; but in that this is a description of an *area* of the earth's surface, it is still geography; not history, or 'social studies'.[5] The story of the growth of, say, dairying in New Zealand—the march of events—is usually known as economic history: in that it is the story of a movement over a period of time it is history, not geography or 'social studies'. The study of the local area is a part of the regional geography of the world –the easiest part for the child to understand, and therefore the starting point. He observes it as it is today—its essential characteristics, its present 'personality': that is geography. He learns the story of the local area—what occurred at earlier periods and what has led to the present organisation of the local community: that is history. Can any teacher who has on his timetable the subject 'social studies' choose any one such lesson from his year's programme and say it is neither history nor geography, but something different from both?[6] The actual effect then of the 'new' course is to prevent the better teaching of the two subjects, as the time available for them is reduced, and the teacher's freedom to choose his methods and content is correspondingly diminished.

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[3] G. Jobberns: 'Geography and National Development', *New Zealand Geographer*, Vol. 1, No. 1, April, 1945, pp. 7–8. Teachers probably do 'wonder' when the geography prescription includes 'social and economic organisation', and the School Certificate Examination history paper for Nov. 1946 includes at least four questions which, in whole or in part, come under this heading.

[4] Kenneth B. Cumberland: *The Geographer's Point of View*, Inaugural Address, Auckland University College, April 2, 1946. Auckland, 1946, pp. 17–19.

What Geography Should Be Taught?

If then to introduce something new in the way of names is not the best method of improving the teaching of geography, it is necessary to suggest other methods of doing so. In other words, it is incumbent to suggest what might be considered the 'right' kind of geography for our postprimary schools. Geography in schools could profitably be based on the philosophy of the subject which underlies its teaching in the universities. (It is of interest to record in passing that the Thomas Committee included no university geography teacher—no university history teacher for that matter—nor postprimary school geography teacher: nor apparently were university geography teachers consulted.

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[5] A number of such studies have recently been undertaken in New Zealand: see, for example, Joyce Deane: 'The Loburn Run, North Canterbury', *New Zealand Geographer*, Vol. 2, No. 2, October 1946, pp. 345-354; Kenneth B. Cumberland: 'A Century's Change: From Natural to Cultural Vegetation in New Zealand', *Geographical Review*, Vol. XXXI, No. 4, October, 1941, pp. 529-554; and Mary Aitken: 'The Maniototo Basin: From Natural to Cultural Landscape', elsewhere in this issue.

[6] The 1946 School Certificate Examination papers in history and geography again illustrate this point. These papers each include a question on the candidate's home area. The history question is concerned with the growth and present organisation of the local community; the geography question with the observation of the present features of the local area. What else could be asked, of the 'social life of the pupil's own local community'?

would not be unreasonable to suggest that the 'social studies' curri-
ulum might have been coordinated with that of history and geography
s taught at the universities. Had university teachers been consulted,
ie method adopted of improving the teaching of geography in post-
rimary schools would probably have been more in line with present
hought in the universities.)

> 'In the schools [geography] has been more widely taught; and its teaching has
> nown marked improvement. In recent years fully qualified geography teachers have
> egun to enter the schools for the first time. The effect of the demands of the new
> llabus is unfortunately largely to annul the advance and cancel out the progress
> ready registered. Geography was beginning to see its way through to clear purpose
> nd objectives. The new regulations tend to destroy again its individuality and
> istinctive point of view; in this fusion both history and geography may be lost—
> eography more especially because in the absence of geography specialists (and this is
> ill the case in most secondary schools) the teacher with qualifications in history (or
> nglish) is made responsible for the new mongrel subject.'[7]

What then is the present philosophy of geography? For the practical
urposes of a school classroom, it can perhaps be said that geography is
study of the peculiar characteristics of different areas of the earth's
rface. As no two areas have completely similar characteristics, this
udy involves the differentiation between areas. It would seem that
ne of the best ways of tackling this study of areas in schools is by
iving to the pupil tiny samples of areas, wherever possible. For
stance, a dairy farm in the Waikato,[8] a spring wheat farm in North
merica,[9] a cotton mill in Lancashire. It is usually quite unnecessary to
efine the limits of such an area; and to attempt to do so except by the
ollection and use of scientific data is too subjective a method to be
eliable. For example, the cotton belt of the United States has been
elimited by such lines as that marking two hundred frost-free days to
ie north, and the twenty-inch annual rainfall line to the west:[10] the
oundary between upland and lowland Britain could be taken as
pproximately the seven-hundred-foot contour line. Any regional
oundaries taught should be in some such way related to scientifically-
bserved fact. Even if we do use such lines, it would still be necessary
point out that they are seldom definite lines of demarcation between

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enneth B. Cumberland: op. cit., p. 18.
or such farms throughout New Zealand, see *N.Z.Journal of Agriculture*, 1944-46.
or such a farm, see Jones and Darkenwald, *Economic Geography* (p. 281). This book contains
lso a Chinese farm village (p. 244); a mixed farm in Norfolk, England, (p. 312); a banana farm
Costa Rica (p. 167), and others. See also G. T. Trewartha, *Japan*, for a Japanese farm and
ural village, (p. 199): Preston James, *Latin America*, (p. 488) and *Geographical Review*, April,
932, (p. 237), for a coffee fazenda in Brazil.
ones and Bryan, *North America*, p. 180.

regions, but rather zones of transition. This could be clearly illustrated if (using the above example) we examined a dot distribution map of cotton in U.S.A. with the above lines superimposed.

But is this actually a necessity? Need we, in postprimary schools, become slaves to the 'tyranny of the region'? In so many parts of the world, especially in New Zealand, there is often a 'focal point' from and through which a region has developed, and which will lead us outwards until we find we have reached an area with a different focal point. Here then another region is introduced, and the approximate transition area met and recognised. Having examined the local region, we can teach other small samples of the world, and work outwards from other focal points. We can build up in this way without the necessity of being bound by arbitrarily-chosen regional boundaries.

SYLLABUS CONTENT

What areas are we to deal with? The easiest, most practical, and most obvious answer to this question is that we should treat of those areas that are enumerated in the prescription for the School Leaving Certificate examination. The new prescription however opens with the words, 'The human geography of the world . . . . .' It later specifies areas—all the world except Africa, South America, and (perhaps) Siberia—which should be studied in more or less detail. The fact remains that the prescription as set down entitles the examiner to ask questions on any part of the world, from Tierra del Fuego to Kamchatka. In order to cover such a wide syllabus the geography specialist must feel restricted by time, and therefore in his choice of method and content. Teachers have sometimes been persuaded that restriction of the prescription to anything less than the whole world would curb their initiative. On the other hand, experience has too often shown that it is the width of the syllabus that unfortunately confines our teaching, because it restricts time. The teacher is forced to teach only what the textbook, or previous examiners, have chosen as of the greatest importance. He has no opportunity of developing the study of any region as he would himself choose to develop it. This is confirmed overseas by the recommendation quoted in a recent number of the *New Zealand Education Gazette.*

> 'It would be much better to have one county done thus humanly than to have the entire country covered stodgily with answers to examination questions.'[11]

It is the wide syllabus as much as anything that may tend to force teachers to persist in their efforts to teach 'the wrong kind of geography'. School Certificate candidates are not expected to be prepared o answer questions on the history of the world, nor on all British history since 66 B.C. Why then should they be expected to have at hand answers to questions which may cover the whole field of geography? One solution of this problem is to concentrate on part of the world, hoping for sufficient alternatives in the examination paper. This, it may be argued, is a course that savours of 'cramming'; but if a decent standard is to be attained in the study of an area, it would seem one practical course. Would it not be better therefore to recognise this practical solution, and examine only part of the regional geography of the world? Such a solution would allow teachers freedom to choose their subject matter and freedom to reach a standard that might be expected of third year pupils. Otherwise a superficial treatment of the world in one year restricts content and lowers standards. (The work done during the first two years cannot of course be expected to reach the standard required at the end of the third year.) These lower standards may be reflected in candidates' marks, if the standard required in geography in the School Certificate examination is equivalent to that in other subjects.

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[11] E. J. Orford, in *The Schoolmaster*, quoted in *N.Z. Education Gazette*, June 14th, 1946, p. 179.

CONCLUSION

Two obstacles—'social studies' and the world-wide examination prescription—may then be confining the teacher of geography and depriving him of freedom to use his own initiative; the first by a forced and artificial 'fusion' with history; the second by preventing the full study of the geography of an area because of the necessity to get on' and cover superficially almost the whole world.[12] Under these restrictions the standard of geography teaching must suffer and the teacher, instead of feeling free to make full use of his enthusiasm and nitiative, may well become a slave to textbook and examination syllabus.

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[12] The introduction of the 'short-answer' type of question in the School Certificate Examination for 1946 illustrates the examiner's difficulties under the present wide syllabus. Moreover, candidates could select at least four questions which required no knowledge of what any piece of the earth's surface looks like, and thus answer two-thirds of the necessary number of questions mechanically, without a knowledge of regional geography. This is further emphasised by the fact that a knowledge and understanding of topographic maps was apparently considered of equivalent value, in this paper, to knowing which town is the 'largest', in India, Japan, Mexico and Scotland respectively. The examiner, as well as the teacher would seem to have been forced by the wide syllabus to relegate essentials to a minor position.

NEW ZEALAND GEOGRAPHICAL SOCIETY: BRANCH AFFAIRS

CANTERBURY BRANCH

OFFICERS for 1947 are— *President*: Mr. D. McLeod
Vice-Presidents: Mr. A. E. Flower, Mr. J. L. Hay, Mr. J. Acland
Chairman: Professor G. Jobberns
Secretary-Treasurer: Mr. A. C. Pitcaithly *Hon. Auditor*: Professor A. H. Tocker
Recorder: Mr. J. L. Hewland
Committee: Miss G.Ulrich, Mr. K. W. Robinson, Mr. G. H. Lawton, Mr. L. Pownall

This year meetings are again being held on the second Wednesday of each month from March to October inclusive.

Membership has maintained a very satisfactory position, a number of new members being gained as a result of the Christmas Gift Subscription scheme instituted last year. The increased attendances, following the change to new meeting rooms in 1946, have been most encouraging.

It is proposed that field excursions be held again during the year, preferably in the autumn or spring months. High hopes are entertained of founding a sub-branch this year in Ashburton where there is a group of very keen members.

We extend our very sincere congratulations to Sir James Hight, Professor of History at Canterbury University College, on his recent Knighthood. Sir James, who is well known for his work in the advancement of both historical and geographical studies, was the first President of the Geographical Association (Canterbury), when it was established in 1939.

WELLINGTON BRANCH

OFFICERS for 1947 are— *President*: Dr. J. T. Salmon
Vice-Presidents: Dr. P. Marshall, Dr. W. R. B. Oliver, Mr. D. I. Macdonald
Chairman: Mr. R. J. Waghorn
Secretary: Miss J. K. Finney *Treasurer*: Miss B. Page
Publicity Officer: Mr. J. W. Brodie *Hon. Auditor*: Mr. T. L. James
Committee: Mrs. S. S. Turowski, Mr. N. E. Dalmer, Mr. W. B. Harris, and Mr. D. W. McKenzie

In 1947 lectures will be held on the third Wednesday of each month, from March to October, and the lecture programme will include both New Zealand and overseas topics. An innovation will be a members' evening to be conducted on the lines of B.B.C. Brains Trust. In addition to the regular lecture programme, three film evenings have been arranged and several geographical excursions have been planned for early in the year.

The public lantern lectures given by Miss Mildred Cable and Miss Eva French on 'The Gobi Desert' were an unqualified success, over 1,000 persons attending. A public lecture is to be arranged to coincide with the Scientific Conference to be held in Wellington from May 20-24, 1947.

Following the success of the lectures held last year in Palmerston North and Wanganui, lectures will be held this year in New Plymouth, Masterton and Napier, and it is hoped that permanent sub-groups will be formed in these centres.

All lectures will be open to members and friends and a special drive for student members will be made during 1947.

AUCKLAND BRANCH

OFFICERS for 1947 are— *President*: Professor V. J. Chapman
Vice-Presidents: Professor J. A. Bartrum, Professor C. G. F. Simkin, Mr. L. K. Munro, Mr. H. R. Rodwell, Mr. E. G. Jones
Chairman: Dr. K. B. Cumberland
Deputy-Chairman: Mr. R. A. Watson
Hon. Secretary: Mr. G. G. Harvey *Hon. Treasurer*: Mr. A. W. A. Parkes
Hon. Auditor: Mr. J. K. Bedbrook
Committee: Miss J. Herdman, Mr. E. C. Grayland, Mr. N. Pountney

The Committee has been able to arrange the following attractive programme of lectures for 1947: Mr. L. K. Munro, 'Impressions of Germany in 1946'; Hon. R. Semple, 'The 10-Year Plan in relation to Auckland and the Waikato'; Dr. Gilbert Archey, 'Malaya and Indonesia; People and Politics'; Mr. W. E. Parrott, 'Siam'; Dr. C. Blake-Palmer, 'Caravan Routes of the Libyan Desert'; and two film evenings.

Although membership in 1946 declined disappointingly, a determined effort is being made not only to arouse interest in the city of Auckland, but also in the province generally. Efforts are to be made to establish sub-branches in Hamilton and Whangarei.

OTAGO BRANCH

OFFICERS for 1947 are— *President*: Dr. B. Howard
Vice-Presidents: Mr. P. G. Connolly, M.P., Mr. B. J. Garnier, Mr. G. Simpson Mr. A. J. Sligo
Chairman: Mr. E. Hayes
Hon. Secretary-Treasurer: Mr. A. H. Payne *Hon. Auditor*: Mr. G. S. Kirby
Committee: Mrs. R. R. McNeill, Miss J. McKenzie, Miss D. M. Martyn, Mr. G. D. Anderson, Mr. N. Dew, Mr. D. Sage, Mr. J. C. Smith

The following programme was presented during 1946: Symposium on 'Western Otago' by Dr. F. J. Turner, and Messrs. C. Johnson and M. G. McInnes; 'The Changing Face of Britain' by Mr. Carl V. Smith; 'Pacific Island World' by Mr. G. D. Anderson; 'Forest Policy in New Zealand' by Mr. M. Skipworth; 'What is in a Region?' by Mr. B. J. Garnier; Presidential Address, 'The Petroleum Resources of the World' by Mr. H. I. Sinclair. One evening was set aside for a Film Evening.

With Dr. B. J. Howard as Convenor the Cartographic Committee has worked steadily and hopes to publish a summary of its findings early this year.

Arrangements have been made for the collecting of material for a 'Geography of Otago', to be published as one of the Otago Centennial Publications.

We offer our sincere congratulations to Dr. F. J. Turner upon his appointment as Professor of Metamorphic Geology at Berkeley University and to Mr. O. J. Begg recently appointed Rector of the Palmerston North Boys' High School.

GEOGRAPHIC NOTEBOOK

AN EQUABLE CLIMATE. As a result of the wide use and application of the Herbertson system of 'natural regions' there has been a tendency to emphasise the climatic similarities of those regions 'enjoying' the West European (or Temperate West Coast) type of climate, and to overlook geographically significant differences. This may explain the inclination to give prominence to the equability of New Zealand's climate and the failure of elementary texts and of popular descriptions of the Dominion to take account of the eccentricities which, because of their frequent if irregular occurrence, may be said to characterise New Zealand's weather and climate.

Some of the more unusual features of the New Zealand climate were recently pointed to in a study of the Dominion's soil erosion problem, and others are remarkably well featured in the most recent State Forest Service *Annual Report* (1946). The report suggests that there was a tendency to suspect that earlier annual statements had overstressed the vagaries of climate and had drawn too gloomy a picture of their effects in forestry. The weather of 1945-1946, however, included capricious variety enough to serve as a healthy corrective.

The winter of 1945 in Canterbury provided precipitation of very heavy intensity (see *In Our Contemporaries* elsewhere in this issue), nor'west gales of exceptional severity and deep snow followed by a week of unusually hard frosts; and all this occurred within the compass of a few weeks. The gales cut swathes through North Canterbury exotic forest stands and laid low many miles of valuable shelterbelts. It is estimated that 4,000 acres of pine forest were destroyed by windthrow and windbreak, making deep inroads into Canterbury's limited forests and shelter trees. The spring which followed was cold and wet. The summer thus delayed proved to be one of notable if not unparalleled dryness especially in the northern half of the North Island. Rather high temperatures and continuously low humidity accompanied the drought. The drought itself caused many deaths amongst exotic conifers; and there are Auckland reports showing that mature taraire wilted and died, while in Hawkes Bay the drought killed rimu and black beech in forest stands. Very much more serious was the attendant and unprecedented fire hazard which persisted through January, February and March, 1946. Extensive forest fires occurred in Coromandel, Hawkes Bay, at Taupo, and in Nelson and the Wairarapa. Some 373 fires were recorded, sixty-two of them in State forests. Almost 60,000 acres of forest and 530,500 acres of scrub, fern and tussock were involved.

These are but the highlights of the weather vagaries of the year. They and others are listed in full in a most illuminating statement in the *Annual Report* mentioned. Such eccentricities cannot be ignored for they are both economically and geographically significant.

KNOW THY NEIGHBOUR. A short time ago the editorial columns of the Dominion's press gave prominence to a broadcast address delivered by the Vice Chancellor of the University of Melbourne. On a visit to New Zealand Mr. Medley took the opportunity of emphasising the Australian's ignorance of New Zealand, and the New Zealander's ignorance of Australia. He pointed out how, despite their relative proximity to each other and their similar origins, traditions and culture, the Dominion and the Commonwealth have their backs 'turned on each other'. Editorial comment welcomed the Vice Chancellor's observations and also his proposals for increasing mutual knowledge and understanding between the two British countries. His suggestions included principally the provision of facilities for the more frequent exchange of university students and staff, and of orchestras and artistic works. Geographers will feel confident in promptly offering an additional suggestion, for it is their task to see that other places are known and understood by describing and interpreting the regions of the earth—continents, countries, provinces and places. It is part of the geographer's duty to interpret the Commonwealth to the Dominion and the Dominion to the Commonwealth. Unfortunately the geographer has been seriously handicapped in this part of his task. Until recently geography has been very much a 'Cinderella' in the syllabus of instruction in New Zealand schools, colleges and university; and while this is happily no longer true of New Zealand, it still has wide application in Australia. The Department of Geography in the University of Sydney was the first, and for long the only, department of its kind in either country. In that capacity it has performed yeoman service. With few notable exceptions virtually all the readily available information on the geography of Australia derives from the publications of Griffith Taylor and his successors at Sydney. Moreover, our valuable contemporary, the *Australian Geographer* is edited from that department. As a result it is not surprising that New South Wales is better known and understood in New Zealand (and elsewhere) than the other states of the Commonwealth. Much the same is still true of Canterbury in New Zealand. But while courses in geography are now available in all four centres of university instruction in New Zealand, geography is still taught only as an appendage of geology or economics in four of the five main university centres of Australia.

It would immediately assist the wider diffusion of accurate information about New Zealand in Australia if each university in the Commonwealth were provided with a full and independent department of geography. Moreover the research undertaken and reports published by such departments would soon assist in the wider diffusion of accurate information about Australia in New Zealand. Few proposals for increased mutual appreciation could return such immediate and permanent results: few could so readily assist towards obviating the lack of understanding which Mr. Medley and all Australians and New Zealanders deplore: few could so materially assist the sympathetic co-operation promised by the Canberra Pact. It is encouraging to know that the University of Melbourne recently established a lectureship in geography in the Department of Geology. Geographers hope that this is but the forerunner of a more important development not only at Melbourne, where Mr. Medley is Vice Chancellor, but also in the Universities of Queensland, South Australia, Western Australia and Tasmania.

SPELLING HOWLERS. There is general agreement that the ability of pupils in New Zealand schools (and even that of university students) to spell common words correctly leaves very much to be desired. Whether ability to spell and general literary attainment is inferior to what it used to be is another matter. He is a bold (or rash) man who, with anything less than fifty years' experience, would argue in one way or the other. What really matters, however, is the standard of attainment of the contemporary generation of school children and university students; and any batch of examination scripts in a subject requiring essay-type answers is sufficient condemnation of the low standards now obtaining.

The geography or history (or 'social studies') teacher must take much of the blame for this and as much of the responsibility in any attempt to lift the levels of attainment. All sciences use an assortment of words which are infrequently used elsewhere. These include a host of proper names and technical terms and also a range of more ordinary if not very common phrases. Many of these cannot be avoided or discarded even in the elementary studies of these sciences conducted in schools. But *why* avoid them in schools? Why not take this early opportunity of making sure that the most indispensable of the specialist terms are fully understood and correctly spelled? Geography, which from certain points of view impinges on a variety of other sciences, has more than its share of such words. Even the schoolboy who studies geography must be familiar with terms used by geologists and geomorphologists; he must know the names of plants and animals, of breeds of stock and varieties of cultivated crops; he must have some acquaintance with the terminology of miner, farmer and manufacturer: most important of all he must know where places are and how to spell their names. That today this is not always the case is shown by candidates' failure to understand such terms when they occur in examination papers. It is still more apparent in the irrelevant answers which result. It is evident enough in the use of such phrases as 'steele mines' and 'irogated orchids in which sitrous fruit such as raysens grow'. These might be extreme examples, but less extreme variants are by no means infrequent. It is for example no uncommon misconception amongst school certificate and university entrance candidates that 'proones', 'raisons' and 'currents' *grow*. A batch of recent scripts contained all these and many more misspellings and misconceptions. New Zealand farms were alleged to be stocked with 'Romanies', 'Koreadales' and 'Marinas', or with 'Bollangus' and 'Hollesteens', while the New Zealand farmer is said to be familiar with such crops as 'chowmoliar' and 'lose-earn' and to make a concoction called both 'insulidge' and 'inchalige'. The child's introduction to terms like these is in most schools principally through geography. The geography master (or mistress) must take some of the blame for the child's inability to spell them and/or for his failure to appreciate their significance and true connotation. The geography teacher is little less responsible for failure to prevent such spellings as 'iren orr', 'tinn' and 'lede', or the old annual 'peninsular'. (In a recent examination less than three per cent of candidates had this latter noun correctly). On the other hand sole blame for the misspelling of place names rests with the geography and history teachers.

There would seem to be evidence enough that the situation is not improving and that 'visual' education, project work and other recent developments in the scope and method of teaching geography might possibly be making rather deep inroads into the time necessary for basic preliminaries and formal drill.

GEOGRAPHY IN THE UNIVERSITY. Twelve months ago we were able to record the provision of courses in geography at Auckland and Victoria University Colleges and in the University of Otago, and to announce the appointments to new university teaching posts of Dr. Kenneth B. Cumberland, Mr. B. J. Garnier and Mr.

H. Lawton. After Volume 2, Number 1 of the *New Zealand Geographer* went to ess, Mr. D. W. McKenzie was appointed Lecturer in Geography at Victoria niversity College. It is now equally pleasing to record that the successful introduction Stage I classes is reflected in expansion of the new departments. Teaching staff is to increased at Canterbury University College as well as in the new departments Auckland, Wellington and Dunedin. Mr. G. H. Lawton (formerly lecturer) has been ppointed senior lecturer at Canterbury University College. At Auckland Mr. R. G. ster, B.A. (London), recently serving with the Royal Engineers as specialist surveyor d cartographer in India, Burma and Malaya, has been appointed lecturer. The post junior lecturer there will be filled by Mr. J. W. Fox, B.A. (London), who perrmed specialist duties during the war with the R.A.F. in the North African and editerranean theatres, and whose geographic observations have recently been scribed in *Geography* and elsewhere. More recently news has come to hand of the ppointment of two branch officers of the Society, Miss J. K. Finney, M.A. and r. K. W. Robinson, M.A., as temporary junior lecturers at Victoria and Otago spectively. Miss Finney is the hard-working secretary of the Wellington Branch and as until recently geographer at the Reserve Bank of New Zealand. Mr. Robinson is a ember of the committee of the Canterbury Branch and has done research in methods mapping land utilisation (see the *New Zealand Geographer*, Vol. 2, No. 1, April, 1946).

EOGRAPHY THROUGH SHIP ADOPTION. A valuable aid to the study of eography in schools is the 'adoption' by schools of a merchant ship. Under the heme operated by the British Ship Adoption Society, Dixon House, 1 Lloyds venue, London, E.C. 3, a school adopts a ship, takes a particular interest in its oyages and cargo and corresponds regularly with its captain. The pupils write tters asking any questions to which they require answers: they ask about the places ited and cargoes carried; the captain in his answers provides appropriate information out distant peoples, places and products. He may also send track charts and cargo ans together with an account of where and how the goods which his ship carries e produced; in some cases he may supply small samples of the materials found riodically in the holds. If the school is situated near the port where the ship calls e pupils may pay the ship a visit of inspection to see the variety of goods brought d to talk with the crew about the foreign countries visited. Most tramp steamers ake calls at a variety of ports and carry a lengthy and intriguing list of goods.

This method of learning and teaching geography has proved very successful in ngland over a period of ten years. The organisation which conducts it is maintained grants from the shipowners and from the United Kingdom Ministry of Education. hese two facts are in themselves sufficient reason for suggesting that similar success ould be attained in New Zealand and that such a method of teaching social studies ould have the interest and even the material assistance of the New Zealand Department of Education. The support of the growing body of geography and social studies achers in both primary and post-primary schools is assured. Those teachers requiring rther information should meanwhile write to Mr. Nelson Pountney, Takapuna rammar School, Takapuna, Auckland.

IN OUR CONTEMPORARIES . . .

1. *In New Zealand Journals . . .*

Studies in Farm Management

This valuable monthly series of articles continues to appear in the *New Zealand Journal of Agriculture.* The subjects dealt with in the months from June to November, 1946 (inclusive) are:—

1. A Tauranga Dairy Farm. A long introduction to this article summarises admirably the advantages of soil and climate which characterise Tauranga County. Stress is laid on the fact that there is ample room and opportunity for further settlement. Of special interest is the decline in maize production consequent upon the introduction of topdressing, certified pasture seeds and straightout grassland farming. Tauranga County has 1,100 dairy holdings with 51,800 cows in milk and a butter output of 7,000 tons. The dairy farm described as typical is one of 150 acres in the Pongakawa district a few miles from Te Puke. The article traces the development from 1914 when it carried 39 cows and 27 head of other stock to the present time when 127 cows are being milked and all herd replacements are reared on the farm. Winter feed is provided for the cows by means of lucerne ensilage and lucerne and pasture hay; the few acres of maize and carrots are reserved for the pigs which yield a return of £410.

2. A Hawkes Bay Coastal Sheep Station. It is widely recognized that the coastal belt from Cape Kidnappers to Cape Turnagain contains some of the healthiest sheep country in New Zealand. This article describes the Pourerere sheep station situated on the bay of that name. It has early associations with Captain Cook who landed there in 1773 and presented the local Maoris with two boars and two sows, the probable progenitors of all the wild pigs which later roamed Hawkes Bay. Favoured with numerous beaches and safe anchorages settlement commenced from the sea. Bracken-fern, the main natural cover was soon replaced with English grasses. The present homestead was built in 1876 from kauri timber brought from North Auckland by sea. Until 1917 when a good road was constructed to the railway at Waipawa all wool was dumped on the foreshore and hauled out to the surfboats by bullock teams. The station today consists of 3,364 acres carrying 6,500 breeding ewes, 3,000 hoggets and 900 head of cattle.

3. A Manukau Mixed Farm. Nearly two million bushels of grain are at present imported annually into the Auckland Province for stock feed. Manukau County, now devoted almost entirely to dairy farming at one time had extensive areas in cereals. That it could grow large quantities of cereals again (in combination with dairy farming) is shown in this description of a farm of 200 acres at Pakuranga. The farm provides a livelihood for three families by producing annually 40,000 gallons of milk, 400 bushels of wheat, fifteen tons of wheat straw, fifteen tons of rye straw, 1,200 lbs. of wool, 150 fat lambs and up to 200 store lambs fattened on rape. 'Whether the combination of a small herd of high average production (attained by supplementary feeding and good pastures) with a cropping programme of cash crops, gives a greater financial return than a larger herd on the same area depending solely on permanent

grassland, is a subject conducive to lively debate, but there is a fairly widely-held belief that the mixed farming with its due balance between crops and stock makes for more stability for the individual farmer and for a healthier system of agriculture'.

4. A Marlborough Mixed Farm. This farm of 216 acres of heavy land at Spring Creek in the lower Wairau Valley is described as an example of the methods practised on an area where diversification is considered the best method of 'safe farming'. A herd of twenty-five pedigree Jerseys is kept; this is the prop on which farm production rests. A few pigs are kept for sale and home consumption and these use the dairy byproducts. Ninety ewes provide meat, wool and fat lambs but their main use is to clean up paddocks after cropping. Small seeds are harvested from the pastures when conditions are suitable, perennial ryegrass yielding fifteen bushels and white clover up to three bags per acre. About thirty acres of garden peas are expected to yield at least forty bushels and wheat, barley and oats are also grown each year. Farm work normally occupies two men and a boy, quite an array of mechanical equipment together with four working horses which are necessary for cultivation and harvesting. An outstanding lesson that this farm provides is the effect of stock in maintaining soil fertility for cropping.

5. A Taihape Sheep Farm. Some 1,300 acres of fully developed grassland, ninety acres of native bush and ten of exotic plantations and shelterbelts allow of the wintering of 3,760 sheep and 600 cattle on grass alone. The owner was a pioneer in the use of artificial fertilisers over twenty years ago and only wartime problems delayed the implementing of a liming programme designed to apply two tons per acre over the whole property. Second growth is absent. The cleanness of the pastures is attributed to a policy of dealing effectively with weed invasion before the exotics have a chance to become strongly established. Brackenfern and bidibidi have been eradicated by heavy stocking with cattle during the winter and by the maintenance of a close pasture sward.

Also of geographic interest is an article: 'Developing A Pumice Land Farm', *N.Z. Journ. Agric.*, Vol. 73, No. 4, Oct. 1946) which describes the experience of two families 'who had the courage to develop an uninviting section of scrub and tussock into a productive farm at a time when the prices for primary produce were low and the prospects for farming success on the pumice lands were somewhat uncertain'. A week's trek from Palmerston North in November 1930 brought these men and their possessions through Taupo to Ngakuru and along a dusty pumice road to the 98 acres where their tents were pitched among the scrub in the wilderness.

The article describes the steps by which two successful dairy farms have been built, one of them carrying a pedigree Ayrshire stud with a New Zealand-wide reputation. Not the least useful section of the article is that which describes the evolution of a house which started as a two-roomed shack and is now a pleasant home of three bedrooms, two living rooms, kitchen, bathroom, laundry and sunporch, which changed and grew in a living way even as the family who occupy it have changed and progressed.'—L. W. McCaskill.

Climatic Vagaries

VARIATIONS OF MONTHLY RAINFALL IN NEW ZEALAND: C. J. Seelye, *New Zealand Journal of Science and Technology*, Section B, Vol. 27, No. 5, March 1946, pp. 397-405.

NOTES ON THE CANTERBURY FLOODS OF FEBRUARY, 1945: E. G. Edie, C. J. Seelye, and J. D. Raeside, *New Zealand Journal of Science and Technology*, Section B, Vol. 27, No. 5, March 1946, pp. 406-420.

Although New Zealand is insular in position and small in total area, its climate is marked by considerable regional variety. Upwards of a dozen major climatic types can be recognised and it is significant that by far the majority of these differences are to be found in areas below 2,000 feet above sea level, and this in the inhabited parts of the country. The underlying cause of these differences lies in the relation of mountain system to prevailing winds so that the chief contrasts which exist are between west and east coasts, although important differences between North Island and South Island (largely a consequence of latitudinal position) are also observable.

Variations of Monthly Rainfall in New Zealand is a study which gives further evidence of the contrast between north and south and west and east. The paper is largely a continuation and amplification of the author's previous article (see C. J. Seelye, 'Variability of Annual Rainfall in New Zealand', *N.Z. Journ. Sci. and Tech.*, Vol. 22, No. 1b, pp. 18b-21b, 1940) in which the general conclusion is reached that 'variability decreases with latitude' and 'variability increases from west to east'. The present paper would seem to support more particularly the second of these conclusions. The marked contrast between west and east is clearly seen by reference to the series of maps showing mean variability of monthly rainfall. These indicate that, with the exception of February, practically all areas where the mean monthly variability exceeds fifty percent are east coast areas, or at least east of the main mountain axes, and frequently the more lowlying districts.

The contrast between North Island and South Island is reflected not so much in the mean monthly variability for the year (North Island 44 percent, South Island 45 percent) as in the seasonal distribution of the variability. Both islands have a maximum variability in February, 57 percent for the North Island and 52 percent for the South Island; but whereas the variability of winter months in the North Island is comparatively low (all months from June to September inclusive display a mean variability of less than 40 percent), the same period in the South Island shows, by comparison, a much higher variability (in fact July in the south, mid-winter, has a variability of 49 percent which is second to February as the month of highest variability for the year). In other words, the range of variability between summer and winter is a good deal higher in the North Island than it is in the South Island. It should also be noted that a graph curve for the monthly variability is far more symmetrical for the North Island, with a February maximum and a July minimum, than for the South Island.

Two other conclusions reached by Dr. Seelye are worth recording. The first is that an analysis of frequency curves leads him to state that 'negative departures of ainfall from average always outnumber the positive ones, and very appreciably so when the variability is large.' The second is in relation to runs of rainfall above or elow normal. From these it is apparent that there is a slightly greater likelihood of ong runs (three months or more) of rainfall below normal than of similar runs of ainfall above normal.

That it is possible at times for regions in New Zealand where the average monthly ainfall is low to experience remarkably heavy falls is well brought out in *Notes on the Canterbury Floods of* 1945. The paper is in three parts. The first, dealing with the meteorological situation before and during the period of high rainfall, indicates that he situation arose as the result of the existence of a quasi-stationary front over the outh Island and the fact that the intensification to the south of New Zealand of an nticyclone redirected east-northeast a depression which had pursued a southeast course across the Tasman Sea; the turning point of this depression was over south and mid-Canterbury.

The result of this meteorological situation is presented in the second part of the paper. It shows that there was a heavy two-day period of rainfall in South Westland on February 18 and 19 and a similarly heavy fall in Canterbury on February 20 and 21, specially between Strathmore and Geraldine and a small area southwest of Timaru. n relation to the latter fall it is worth noting that 'as in many other exceptional rainstorms, the influence of orography is not conspicuous and the rain pattern bears no resemblance to the average distribution of precipitation; the highest falls in Canterbury were on the lowlands, an outstanding fall of 13.93 inches in 48 hours occurring at Strathmore, and rainfall *decreased* towards the foothills. These heavy falls followed what had, for eastern districts, already been an unusually wet month and many stations with thirty-year records or more in mid and south Canterbury experienced the heaviest February falls ever recorded.

Short period heavy rainfall frequently causes much damage to land, crops and ransport installations. The rains of February 20 and 21 in Canterbury were no xception to the general rule. Information regarding the extent of the destruction is provided in the third part of the paper under review. Slipping and slumping occurred on the mountain slopes and gully and rill erosion was noted on the downlands. Damage in the latter area was not extensive since there was comparatively little ultivation. Some noteworthy observations on the effects of rain on cultivated and were, however, made. While ploughed fields still in a rough state did not rode, those broken to a fine tilth suffered to some extent. Where crops had been lanted the direction of sowing materially affected the amount of soil loss. 'In one ield of mangels planted up and down the slope a gully had developed between each ow. In this field, at the foot of a 9° slope eighty yards in length, silt had collected to a epth of 18 inches in a depression eight yards wide. From a similar slope one hundred ards long planted along the contour a deposit of silt only two yards wide and two nches deep had accumulated. Wheat paddocks in which the wheat was still standing howed no gullying; where the crop had been reaped, gullies developed on slopes of bout 14°. Erosion on the plain was limited to stream bank erosion and the major amage occurred to bridges and roads, particularly in Geraldine county where 12 ridges were destroyed, 11 badly damaged and the approaches to 25 suffered washouts.

Taken together the two articles are useful descriptive analyses of aspects of the diversity of New Zealand's climate. The prevalent practice of judging climatic characteristics from a limited number of temperature and rainfall normals is one which is seriously questioned by geographers and others. So far as New Zealand is concerned it has frequently given rise to the erroneous impression of climatic similarity throughout the whole country. The two articles examined are salutary correctives to this view.—B. J. Garnier.

2. *In Overseas Journals . . .*

New Zealand and International Cooperation

NEW ZEALAND IN THE WORLD ECONOMY: Leicester Webb, *International Affairs*, Vol. 22, No. 2, April 1946.

As Mr. Greenbie has recently pointed out so pithily, New Zealand's main economic activity is with the output of a limited range of animal products. But an undiversified economy, selling primary products overseas is likely to be hard hit by changes in the economic climate abroad; hence Mr. Webb correctly interprets the New Zealand economic position and policy today as being essentially conditioned by the 'sensitivity' of this few-products-single-market position.

And so we have to resolve these economic forces: internal control of farm prices and costs, the question of economic diversification of production and the demands of internationalism and non-discriminating trade policy. Compromise is necessary, and Mr. Webb suggests that internal controls will not be sacrificed to a more distant ideal of international cooperation; this country will approach the new internationalism (Bretton Woods, for example) with saving clauses regarding local economic autonomy. Mr. Webb gives us a good conspectus of these points couched in 'this is' rather than 'this ought to be' language.

And the problem for New Zealand is similar in kind if not in degree to that confronting other nations. How far can the compromise between growing economic internationalism and the internal measures necessary to maintain full employment be made workable? Ultimately we are brought face to face with a moral question, of belief in the goodwill and integrity of nations in the international sphere. The tide of faith ran full with the Atlantic Charter:

'Mother, may I go for a swim?'
'Yes, my darling daughter.'

But since the end of hostilities the international situation has been wearing a trifle thin; the fate of UNRRA and the United States withdrawal from the International Food Organisation are bad portents:

'Hang your clothes on a gooseberry bush,
And don't go near the water.'—A. J. Danks.

REVIEWS

Sheep Country

HE EARLY CANTERBURY RUNS. By L. G. D. Acland. Christchurch: Whitcombe and Tombs Ltd., 1946, pp. 367.

MURI. By L. R. C. Macfarlane. Christchurch: Whitcombe and Tombs Ltd., 1945, pp. 132.

hese two books add to the growing store upon which our understanding of New ealand can be built. The literature of a people grows gradually and depends upon the ow building of a characteristic national culture, which only becomes distinctive after any years, even centuries, of occupation. During this period much must be written hich is not in itself great literature, but which helps to form the picture of a nation.

The early stations of Canterbury and the life of the people who settled and worked em have had a great bearing upon the atmosphere of the province. These two books, very different form and style, bring to us a picture of that early life.

The Early Canterbury Runs contains in one volume the first, second, and third ries of Mr. Acland's accounts of the Canterbury stations. It is indeed fortunate that as rly as 1894 one man was interested and far sighted enough to begin collecting this luable historical material. He has never slackened in his efforts to acquire information; d, in spite of a disastrous fire which at one time robbed him of all his notes, he can ill present us with a book packed with authentic facts and with many an anecdote of an nusing or interesting nature.

The scope of Mr. Acland's work is so large that he has been forced to treat each operty briefly; some of the accounts are just a collection of historical facts with tes upon the boundaries, stock and changes of ownership. Much of it may make ll reading to anyone unfamiliar with Canterbury, but what a picture it conveys of e early life, the struggles and the failures, the trials and the triumphs of the early ttlers! To those who know and love the sheep country what romance there is in the ames and stories of the runs! From Te Waimate to Lake Sumner, from Banks eninsula to the Southern Alps, he traverses the country and tells the story of the land d of the people. Among backcountrymen, I know of no book which excites greater terest. The pictures called up by its stories of men and mountains, sheep and rivers, ogs and horses are endless. Lochinvar and Cora Lynn, Mesopotamia and Mt. Algidus, rari Gorge and Mt. Possession: the very names are music to the ear and are as much part of the story of Canterbury as the name of any town. One day a writer of fiction ill come who can weave the atmosphere of the station life into his stories and make a le as full of native character and romance as any writer of an older country. Perhaps e station life is dying out; certainly it is under a cloud just now as a result of the soil osion menace. Let us not condemn it too readily, but try to understand what it ntributed to the people of New Zealand, what courage and endurance it bred, and hat deep and true affection it had for the land of hill and mountain, snow and sun d wind.

Mr. Acland has done a great service to us all and to future writers of history and ction. The book is well indexed as to stations and men.

The second book, *Amuri*, covers similar ground but in a very different manner. It surveys a part of Canterbury, the Amuri, almost untouched in Mr. Acland's book. There are obvious criticisms (they have already been made) of the writer's style and manner of presentation, but it is the work of a man who loves his country, a busy man with much to do and many thoughts in his head; if his words tumble out with scant attention to buttons and bootlaces they are not unlike those of the early settlers of whom Mr. Macfarlane writes.

The book is divided into sections; Part I, 'The Maori', is an imaginary description of the penetration of the first Maori into the Amuri 'the hereinafter—the promised land—the country that is different'. Then follow the whalers, the surveyors, the cattlemen, and finally the sheepmen; brief descriptions are given of the coming of these men and the passing of all but the last. Part II is the diary of 100 years, which the author describes as a very broad translation with no claim to historical correctness, but which endeavours to resurrect the spirit, the thoughts, and the doings of the successive periods. This is the story of the Macfarlanes, three generations of a family which came early and fought and won the battles of these 100 years. Someone has described the Amuri as 'a very plain plain almost entirely surrounded by Rutherfords and Macfarlanes'. The family may be accepted as almost as much a part of the Amuri as Lowry Peaks or the Hurunui River. As Mr. Macfarlane says 'the land is always greater than the people, unless the people love and understand the land'. The first generation describes the arrival of the first Macfarlane and his early struggles to get land; settlement at Loburn; the breaking in of the land; the outbreak of sheep scab, and the days of the bullock waggon. Always in his mind lingers the memory of the Amuri seen during a trip with surveyors during his stay in Nelson when he first arrived. At last his dream comes true and he buys Hawkeswood. His second generation (1872-1908) is established at Kaiwara, part of the old St. Leonards run, and here we see the days of great development, building and subdivision; the days of spanking harness horses, the stable full of well bred hacks, when men thought nothing of riding from Hawkeswood to Rangiora between one dawn and the next. The third generation skips briefly over the years of the last war with a few characteristic sketches of events.

In Part III Mr. Macfarlane makes an imaginary 'Modern Journey' through the Amuri, telling as he passes something of the story of that rich land; lingering here and there to recall a half forgotten tale and enjoying to the full his 'promised land'. Kipling wrote:

> God gave all men all earth to love
> But, since man's heart is small,
> Ordained for each one spot should prove
> Beloved over all.

There is no doubt where lies this author's heart.

He concludes his book with a few sketches of people from the past and an epilogue consisting of a brief and satirical glimpse into the future. I should like to quote one passage from his 'Modern Journey' which we should all do well to take to heart. Referring to early settlers he says, 'many kept their feet and their properties, but it was mostly by the old fashioned method of not spending their money. What we today, the lucky descendants of the pioneers, must appreciate most is not the hardihood of our forebears—they were young and life was a great adventure—but the sticking it hrough the bad seasons and the disappointments, the doing without, the turning of ast year's dress and patching of trousers. They had great hope and even greater love f the young country they had settled in, and in the end, these are even greater than a omfortable balance in the bank'. Herein has lain the past greatness of New Zealanders. They knew and loved their land; they lived in it, not on it, and so were worthy to be matched with it in greatness.

The publishers are preparing a revised edition of this book in which the buttons nd bootlaces have received more careful attention. Let us hope that in the process he author's personality has not been obscured.—David McLeod.

Accelerated Erosion

OIL EROSION IN AUSTRALIA AND NEW ZEALAND. By J. Macdonald Holmes. Sydney: Angus and Robertson Ltd., 1946, pp. 296.

rofessor Holmes is a geographer. It is the special task of the geographer to interpret he elements of landscape in their entirety. We could reasonably have expected the uthor of this book to have presented a comprehensive picture of the problem of soil rosion in Australia (if not of New Zealand too), to have applied the geographic method in examining the complex of factors which make for the regional differentition of soil erosion morphology, and to have attempted to explain the physical and ultural factors which have influenced soil deterioration. We could reasonably have xpected that a book by the head of a university school of geography would be a model of geographic methodology.

It is to be regretted first that it was published under such an inaccurate title. It would have been much fairer to have given it some such title as 'Some Previously Published Information about Soil Erosion in New South Wales (together with a collection of irrelevancies about climate, irrigation and soil classification).' The use of he words 'New Zealand' is inexcusable; the sole references to New Zealand are some ecords of the arrival of Australian dust, a page and a half summary of the Soil Conservation and Rivers Control Act, a summary of a paper by Dr. K. B. Cumberland n the *Australian Geographer*, and four photographs. The author claims to have 'seen the results of soil-erosion and canvassed opinion on the remedies over much of New Zealand'. It is unfortunate that under such a title we have not been given the results f his observations and the conclusions based thereon.

The author even fails to give us a general description or analysis of the causes, ature, areal extent or significance of accelerated erosion in different regions in Australia. There is no connected theme in the book, no logical development of argument or thesis. There is certainly evidence of the collection of informative and valuable material, but much of it is only distantly related to the subject of soil erosion. For instance the chapters on rainfall and prediction of drought and the very full series of climatic maps of New South Wales are doubtless of considerable interest to the student of the climatology of New South Wales. They are of very little value to the student of soil erosion since the author fails to show how the process and progress of soil erosion is related to drought frequency or to the nature and incidence of rainfall. Similarly the relation between the author's treatment of water and soil problems in the irrigation areas of New South Wales and the subject of soil erosion in Australia and New Zealand is, to say the least, decidedly obscure.

But this reviewer would not like it to be thought that the eighteen shillings and sixpence he expended as a result of the book's title and authorship returned no dividend at all. On the contrary all students of geography in general and soil erosion in particular will find much of interest, and will benefit from a careful winnowing of the grain from the chaff.

Part I, entitled 'First Principles about Soil and Rainfall', is probably the most useful section of the book. In the chapter called 'The Soil is Eroding Seriously' the author describes the various types of soil erosion. He is to be commended for including two types often neglected in such classifications: 'Early stages' and 'Road-water erosion'. The latter is a very important form and is only slowly being recognized in New Zealand. The chapter devoted to soil erosion as the greatest peacetime social problem is a confused discussion and probably best summarised by quoting the final paragraph: 'the farmer and pastoralist for their own sakes should know more about the ways in which nature is disposed to help them. They should know more of modern soil science, of drought and flood in relation to agriculture, and of what is available to them from governmental sources to help them to overcome the difficulties of their environment. Finally, the citizen and the parliamentarian must realize that there are complex social problems arising from soil-erosion which still await solution.' Chapter three attempts a stocktaking of the present trends in soil studies, but the discussion is confused by frequent references to special problems in New South Wales which help the general reader no more than does an 'almost self-explanatory' diagram intended 'to summarise the related and various soil studies just discussed.' There are thirty-four wasted pages on a study of drought prediction in New South Wales. The nine-page chapter labelled 'Destructive Rainfall Infrequent' together with the maps, photographs and tables, do not seem to have any connection with the subject under discussion. Most of us however will agree with Professor Holmes in his belief that a weather-recording service should also be 'a bureau which would work out its records, reconsider its basis of data collection and make climatic predictions as well as weather forecasts, and also carry out statistical analyses of weather behaviour'.

Part II, 'Control of Soil-Loss and Water-Loss by Prevention of Rapid Run-off,' is a useful summary of some fairly comprehensive experiments carried out by Professor Holmes and his students on farm properties whose owners were prepared to promote the work and maintain the structures over a period of years. This was pioneer work and the results are all the more valuable in that the projects were carried out under normal working conditions.

Most of Part III, 'Margin and Centre: Two Aspects of Inland Australia' was published as long ago as 1938. It deals with the problems facing eighty million acres in New South Wales, mostly Crown Land, and a vast area in inland Australia, a 'critical environment', and it stresses the necessity for a mental attitude to land totally different from that of the nineteenth century.

In the final section the author asks, 'Can the Problem of Soil Erosion be Solved?' and attempts to answer his question by a tedious discussion of various irrigation schemes with special reference to the Murrumbidgee irrigation areas. The connection with soil erosion and its control in Australia and New Zealand is not mentioned.

A chapter is devoted to summarising the legislation passed by the parliaments of the various States and of New Zealand with the intention of providing machinery for the control of soil erosion, and the final section sets out to suggest some solutions to the problem. Contending that it is a complex social problem the author advocates 'National Help for a National Benefit'. He claims that any bold practical policy of soil-erosion control must eventually add income to the farm but the initiation of such a policy requires farm reorganization beyond the financial resources of most farmers and pastoralists. The necessary finance must be provided by those who will ultimately benefit—the people as a whole . . . . 'Further, it will be necessary to review the national commercial policy, since farmers and pastoralists have often maintained that they were driven to soil exploitation by the conditions of their trading and the like. Soil-erosion issues are of such a nature that the government, scientific research, and practical farming and grazing can have but one objective—namely, an erosion-resistant soil, and this is in no way incompatible with a successful rural economy.'

Despite some lucid and valuable paragraphs, this is a book as difficult to review as to read.—L. W. McCaskill.

Recent Books on Cartography

AN INTRODUCTION TO THE STUDY OF MAP PROJECTION. By James Mainwaring. London: Macmillan and Co. Ltd., 1942. pp. 114.

MAP PROJECTIONS. By George P. Kellaway. London: Methuen and Co. Ltd., 1946. pp. 127.

GLOBES, MAPS, AND SKYWAYS. By Hubert A. Bauer. New York: The Macmillan Co., 1942 and later reprints. pp. 75.

WORLD MAPS AND GLOBES. By Irving Fisher and O. M. Miller. New York: Essential Books, 1944. pp. 168.

Before the outbreak of the recent war, books devoted exclusively to map projections were not common. Apart from some specialized works, severely mathematical and too limited in scope to be of interest to most geographers, the only such work still in print in England was J. A. Steers' *Introduction to the Study of Map Projections*, while Deetz and Adams' *Elements of Map Projection* was the only one obtainable from America. Mr. A. R. Hinks was preparing a third edition of his well-known book at the time of his death in 1945. For a detailed study of the subject, reference must still be made to textbooks in French or German or to papers in various mathematical and geographical periodicals, but within the last few years a number of introductory works in English have appeared.

Dr. Mainwaring's *Introduction to the Study of Map Projection* is striking in the profuseness of the illustrations: of its 114 pages, 51 are occupied with diagrams, the explanatory text in each case being found on the page facing the diagram. The treatment is largely descriptive, some simple mathematics being given in relatively few cases. Only the commoner projections are dealt with, but the work is an excellent introduction to the subject. Some errors have crept in, however: the curious misprint of 'stereoscopic' for 'stereographic' occurs twice, and of the 'normal zenithal equidistant' it is erroneously stated that the meridians and parallels are arcs of circles (the description given is actually that of the Nicolosi or so-called 'globular' projection). The author also contends that 'the scale of zenithal equidistant projections is 1·57 times its "true" length', which can only be regarded as nonsense. What is meant is that the radius of a hemisphere on this projection is 1·57 times the radius of the sphere; since a map is a representation of the surface of the sphere, scale relations must be based upon surface measurements and not upon the radius which lies beneath the surface.

Mr. Kellaway's *Map Projections* is very similar, in scope and content, to Mainwaring's book, but lacks the profuse illustration and careful pagination of the latter. Individual projections are well described, and the properties, limitations, and method of construction in each case are set out under italicized headings. In the simpler cases, an elementary mathematical treatment is given. The chapter on the choice of a projection consists of a discussion of specific geographic regions and the projections suitable for them, but gives no clear statement of the factors which should govern the selection.

Both these books suffer from the retention of the inconsistent and thoroughly unsatisfactory nomenclature that usually passes for 'classification' of map projections, but, since the authors have written in the shadow of examination syllabuses, originality could hardly have been hoped for in this respect. Both include a diagram of a secant conic projection (although Kellaway explains that the conception is a false one), and both speak of the perspective centre as the 'view point', notwithstanding that, if it really were the view point, the projection would be inside out. These practices have hampered a clear understanding of the subject for many years, and a completely satisfactory textbook has not yet appeared.

Mr. Bauer's *Globes, Maps, and Skyways,* with that attractive typography and binding characteristic of recent American textbooks, treats of map projection as one item in an elementary statement of mathematical geography and navigation. Its principal fault is condensation, but this is perhaps not a valid objection since the author's object is 'to simplify the field of cartography . . . without becoming lost in the intricacies of technical designs and confused by the multiplicity of technical terms'. Only a few of the commoner projections are described, the description in each case being regrettably brief; a few interrupted projections are figured without description.

The authors' names should be sufficient indication of the merits of *World Maps and Globes*, for Irving Fisher is Professor Emeritus of Economics at Yale University, and O. M. Miller is Head of the Department of Maps and Surveys of the American Geographical Society. Their preface explains that 'This book has been written as an attempt to supply a simple and general statement on the subject of world maps and globes, mostly by means of illustrations. The text may be thought of as a quiet accompaniment to these illustrations.' The attempt must be regarded as highly successful, and the illustrations are attractive; meridians and parallels are shown by black lines, and land areas by an overprinted colour. A distinctive feature is that twenty equilateral spherical triangles have been added to each map to illustrate the deformations of the various projections.

There are short chapters on globes and on map projections in general, but the book is primarily concerned with world maps on polygnomonic projections—gnomonic projections on various regular solids which can be spread out into a plane or folded into an approximation to a globe. This idea is really very old, for the gnomonic projection on a circumscribed cube was used by Ignatius Pardies, a Jesuit priest, in 1674. (The oldest extant description of the gnomonic projection is that of another Jesuit, Christopher Grienberger, in 1612. It is highly probable that the Greek geometers knew of the gnomonic but there seems to be no direct evidence for the assertion. Ptolemy, who derived the stereographic and orthographic projections from Hipparchus, made no mention of the gnomonic.) The cubic gnomonic projection has been used in astronomical work for several centuries, but the extension to other regular solids is a recent American development, of which a well illustrated account appeared in *Life* for 1 March, 1943. The writers of the present work prefer the icosahedron, which can be opened out into twenty triangular faces. They mention the tetrahedron as the least suitable solid because of the great distortion of the map that would result from having only four faces. It may be remarked, however, that a gnomonic projection on a tetrahedron would have one advantage: it provides for endless repetition of the sphere, so that the faces could be rearranged, or additional faces could be added, in such a way that every face would be in agreement with all adjoining faces, and the projected great circle joining two points would never extend across more than two faces. This is not possible with the icosahedron, nor even with the cube.

A chapter on the uses of world maps stresses once again the misconceptions that arise through the use of unsuitable projections. 'Perhaps the most crying educational need for adults is to unlearn, discard and forget the false pictures of these relationships which have been created by ignorant use or misuse of "world maps".' Many before now have commented that the Mercator projection, indispensable though it is for rhumb line navigation, is quite unsuitable for a general purpose world map. Yet cartographers are reluctant to break away from longstanding tradition, and the Mercator projection still figures in our atlases, geography books, newspapers, and wall calendars. As to which projection is the best for a world map, the authors state, quite rightly, that there is no simple answer. A perfect world map on a plane is impossible, but the polygnomonic map is an interesting compromise.

The book is written for the general reader, avoids mathematics, and attempts to avoid the use of technical terms. There is always the danger in such cases of using a technical term in a non-technical sense, and it is unfortunate that the authors should have used the term *grid* to mean 'any network of lines, such as meridians and parallels'. The network of meridians and parallels is properly called a *graticule*; the term *grid*, introduced by the late Brigadier Winterbotham as the English equivalent of the German *Gitternetz*, is applied to the network of squares formed by the rectangular coordinate lines in the plane, and its use in any other sense in cartography is inviting confusion.

The book concludes with a section of questions and answers, some of them well known trick questions such as that concerning the direction of the Panama Canal, some more suitable for American readers, but the majority requiring a good general knowledge of global geography. In their comments on one question, the authors remark that no four international boundaries meet at a point, but that such a state of affairs is probably common among minor civil divisions of the rank of counties. New Zealand has one interesting example, where five counties and nine ridings of counties meet at the summit of Mount Egmont.—L. P. Lee.

Amateur Weather Man

I PREDICT A STORM. By P. H. Jones. Gore: The Gore Publishing Company, 1946, pp. 79.

Mr. Jones, who is a teacher of the Canterbury Education Board, provides in this book a unique eulogy on a device that he has constructed for predicting weather. His method closely follows Californian Floyd Young's system of minimum temperature forecasting in that predictions result from the application of psychrometer readings to a temperature-moisture content chart. Mr. Jones, however, has gone further than the Californian and has moulded '60,000 personal observations' into a chart which he claims to be reliable for the daily forecast. It cannot be disputed that such an instrument could attain some degree of success; the humidity principle was incorporated in several novelty forecasting gadgets which found a ready sale before the war.

Mr. Jones, however, feels that the experts are sceptical and numerous testimonials are scattered throughout the book insisting that the degree of success is not small. He is genuinely disappointed by the indifference and lack of sympathy with which the New Zealand Meteorological Service regards the predictor, and so he enlivens his book here and there by making bitter attacks on the official forecasts and forecasters. In fact the purpose of this work would appear to be the justification of the Jones Local Weather Predictor by illogically comparing a selection of its notable successes with a number of the Dominion Meteorologist's outstanding failures.

Although the author's sincerity of belief is unquestionable, the argument for the predictor is not convincing. The instrument is known as a 'local predictor', but the boundaries of the locality seem indefinitely extensible when a point requires proving. Thus frost and storm warnings conceived at Waiuta are realised at Roxburgh and Christchurch respectively; snow forecasts for Mt. Somers are justified in snow at Dunedin and floods on the West Coast. Timing also introduces a peculiar problem. The predictor does not specify a period for fulfilment, and the warnings quoted have been issued at periods ranging from a few hours to a week prior to the event. It appears that the conditions forecast may be expected at any time within the following week and that the later the occurrence the more creditable the prediction because greater warning has been given.

Mr. Jones has discovered a rather interesting approach to the study of climate, and various regions are compared by their relative positions on the temperature-moisture content chart. He claims that this method proves that Köppen's climatic divisions and Griffith Taylor's Comfort Values are 'absurd'.

The author is in agreement with modern meteorologists concerning the broader features of the frontal theory; but intentionally or unintentionally he has introduced subtle refinements in some of the details and in the application of the theory. Meteorologists must admit that 'to know whether rain, snow or dry wind accompanies the change it is necessary to know the moisture content of the incoming air mass'. They will disagree that 'that is where the hygrometer gives such wonderful results' because the hygrometer is competent only of making measurements of air preceding the incoming mass and totally dissimilar to it.

It is refreshing when, from time to time, the author's obvious originality finds expression in the endowment of a new sense for some of the established terms of his contemporaries; it would appear that Mr. Jones's 'Polar Continental Air' corresponds to the 'anticyclone' of other writers; and so we have confusion such as this: 'for several days this PC mass takes charge (with high barometers and frost risk), passing eastwards, where it is often reported "stationary", and throwing off east winds to New Zealand (*sic*). As it "loses intensity" (flattens or moves away), the incoming northeasterly becomes modified (mPC)'.

The work is not easy to read. It is not so much a book as a scrapbook of unconnected thought. Indeed, the arrangement tends to the chaotic, and the sequence is constantly broken by reminiscences of interviews with famous figures and with accounts of remarkable weather conditions reported over a vast range of time and space. The numbering of the diagrams is eccentric, and in places where the diagram is divorced from the text the reader is called upon to exercise considerable patience and agility to keep abreast of the discussion.—I. E. M. WATTS.

AGRICULTURAL REPORT

PRIMARY PRODUCTION IN NEW ZEALAND. (1946 edition.) Wellington: New Zealand Department of Agriculture, 1946.

This booklet of over 100 pages is a welcome uptodate edition of an outstanding summary of the primary industries in New Zealand. It is a remarkable achievement to have condensed so much information into such a small space and not to have sacrificed interest and readability.

Commencing with a summary of land utilisation, livestock numbers, machinery units, and wool, meat and butterfat production, the booklet goes on to deal with climate, topography and the main systems of farming. In addition to questions of production, some attention is paid to the research organizations behind the farmer. Considerable space is allotted to the systems of wool disposal and to the guaranteed prices for butter and cheese, and there is a useful section on producer organization and their work for primary industry.

It is to be hoped that there will be regular annual editions of this publication and that sufficient will be printed to enable every teacher of geography and every student to obtain a copy.—L. W. MCCASKILL.

A PICTORIAL REVIEW OF NEW ZEALAND AGRICULTURE

PASTORAL NEW ZEALAND: ITS RICHES AND ITS PEOPLE. By Alan Mulgan. Auckland: Whitcombe and Tombs Ltd. 1946. pp. 96.

This book provides a brief review of New Zealand farming—what the farmer grows, how he grows it and how he and his family live. It is written in clear, nontechnical language and illustrated with a wide range of excellent photographs, effectively reproduced on art paper. The wide margins, large and generously spaced type and frequent literary quotations, to illustrate the theme 'all flesh is grass', add to the attractiveness of this art production.

The book will appeal to many readers in New Zealand including teachers and students of geography and social studies. The human approach and wise choice of illustrations make it most suited to their needs. Anyone overseas interested in New Zealand and its farmers will find this an excellent source of information; and the form and content of the book will do much to uphold New Zealand's recently acquired reputation for first class publications.

The author has taken care to ensure that all statements are authoritative and that the illustrations are truly representative of farming in the Dominion: this is not a glamorized version of it. The text is divided into six parts. The first describes briefly the great variety of farming, landscape and climate which a visitor to New Zealand would find—the contrasts for example between the mixed farm beside a tidal creek in languorous, subtropical North Auckland and the sheep station beside mountain-ringed lake waters in Otago or Southland. New Zealand's dependence on grass for its export wealth, the uneven distribution of first class land, the important influences of climate, and the role of agricultural research and education in improved farming practices and the expert grading of meat, butter, cheese and fruit: these topics complete the introduction.

The second section shows the sheepfarmer's advance from a pre-refrigeration wool economy to present day production of wool, mutton, lamb and a little beef. Farm work is also described: 'long days of mustering, scientific breeding for wool or mutton or both, soil improvement, growing crops for fattening and winter feed, selling and buying stock and finally shearing, classing and transport of wool to the stores for the auction which will largely determine the farmer's standard of living in the following year'. Section three describes the dairy farmer's routine and the story of his products: 'butter, cheese, milk powder as well as some pork or bacon'. The fourth section describes the evolution of grain growing in New Zealand towards its present areal localization and the fifth section outlines the work of our fruit and tobacco growers. Finally we are provided with a very useful analysis of the people on the land and of the farming landscape.

The main feature of the book is the number, range and size of the beautiful photographs showing many aspects of farm life and typical New Zealand landscapes. These illustrations are indeed very much better than we find in most books; but they would be even more valuable if accompanied by a few lines of explanation. Admittedly the New Zealand reader knows where the various places are: he hardly needs a map, although the overseas reader certainly does. Yet unless we are familiar with the activity or landscape illustrated we cannot tell how characteristic the picture is; we are also liable to miss the significance of many features all of which could be pointed to in a few concise explanatory statements.

This pictorial approach to the survey of New Zealand agriculture suggests a more ambitious scheme to portray the ways of life, the work and the cultural landscapes of New Zealand. Artists with their colours and powers of selection could, in cooperation with geographers, and possibly also with the Department of Agriculture and the Manufacturers' Association produce a series of paintings with explanatory notes, which could be widely exhibited abroad to show truly what New Zealanders do and how they do it. Exchanges with other countries of such collections of exhibition paintings would do a great deal for international understanding and goodwill.

Finally *Pastoral New Zealand*, although not written as a geography book of the usual type, contains valuable text and most appropriate illustrations. It is a great aid to the understanding of our chief primary industries.—Nelson Pountney.

An Official Review of New Zealand Agriculture

FARMING IN NEW ZEALAND. New Zealand Department of Agriculture *Bulletin* 252. Wellington: Government Printer. 1946. pp. 199.

The Department of Agriculture has issued in addition to its monthly journal a large volume of literature—leaflets and bulletins—embracing a very wide field and offering to the New Zealand farmer written advice on practically all matters relating to his craft. In all these publications can be seen the hand of the specialist concerned primarily with his own particular field of study. It is not remarkable—it is indeed appropriate—that very often in such bulletins the scope of the ground covered is definitely limited to the subject matter and the writer rarely strays into other fields of farming activity even though they may be closely allied to his own special sphere of interest. But in *Farming in New Zealand*, the department has essayed to cover a wider canvas so as to present to the reader a broad view of the farming industry. The opinion of the specialist is expressed as before in Part I but the proximity of the chapters and the tying-in of their sequence by the editorial hand gives more life and purpose to the articles than each would possess as a separate publication.

Chapters III and IV of Part I, dealing with the native vegetation and an historical survey of its adaptation to our farming demands, are most timely, as with the passing of the years, oncoming generations must tend to become more and more ignorant of past conditions. The grouping of the statistical records into periods from 1840 onwards provides excellent material as a basis for the student of our 'comparative agricultural progress.' The next six chapters of Part I dovetail in well as the story proceeds from basic soil management—drainage, cultivation and manuring—to a presentation of the features of our cropping, pasture utilisation and livestock production. In each of these chapters the main points of the subject are sufficiently emphasised as to give to the casual reader a good general picture, and to those who wish to pursue the study further, the basic subject matter for wider reference and reading.

The second portion of the bulletin provides some excellent material, recording as it does the character of the farming practised in different districts throughout the Dominion. It is in the presentation of these articles prepared by fields officers and published originally in the *Journal of Agriculture* that some greater degree of co-ordination might have been introduced so as to correlate the locality and description of the farm with the geographical grouping of the earlier chapters. While the adoption of the standard provincial subdivisions of the Dominion is useful for the presentation of statistical data, such subdivisions do not give a useful guide to the nature of any locality in the farming sense. New Zealand is so 'broken' in both climate and contour that in works of the type under review an emphasis on our geographical subdivisions becomes not only warranted but also imperative. It is suggested therefore that in future issues of the bulletin the maps on pages 90 and 91 should carry the subdivisions set out in Chapter II, pp. 13 to 15, with any additions or modifications which might give greater clarity when the geographical and farm management characteristics are considered side by side.

The series of farm studies contain a wealth of detailed information which in its collation and presentation bears witness to the work of the field officers in its preparation. These studies in farm management have been noticed regularly in the *New Zealand Geographer* (see 'In Our Contemporaries . . . . .').

There is in some of the studies ample material for two distinct articles as for instance in the case of *A Northern Wairoa Farm* and *A Rotorua Dairy Farm* where the actual farm study is preceded by a general review of the district. This review serves a most useful purpose in giving a background to the farming practices detailed but it tends to a dispersal of interest such as is not noticeable when one is reading the *Small Holding* section. It is recognised that in this, the initial series of studies, the district picture is necessary as an introduction, but one may hope that as these farm studies proceed and further publication results, the description of district conditions will, as a separate article, precede the detailed description of several farms in the area. All who are interested in New Zealand farming will look forward to such subsequent publications with interest as they unfold the story of our farming industry.

It would add much to the farm management study if some figures showing current expenses and returns for the farm could be included. Admittedly many farmers prefer that such facts should remain unpublished; in reading *A Woodhill Dairy Farm* one's interest is held to read the story of development, but this interest would be more thoroughly satisfied if some comparative figures were given to show how over the years Mr. Steele's work gradually brought its financial reward. The same thought comes, too, with the story of Mr. Linton's development of his farm at Matakana and of Mr. Martin's farm *Ngongotaha*.

Now that the series has been launched it may be worth while to shape the form of the articles so as to fit them into the pattern of the series—rather than to regard them as isolated stories, provided that the flavour of individualism which each writer conveys is not lost; the impression given that the writer has seen and walked over the land he is telling about comes through his writing and carries such conviction as is often lacking when the article is 'overedited' by others.

The illustrations, maps, graphs and tables which are included throughout the bulletin are well chosen and well presented; they add greatly to the interest of the text. The care in compilation and the orderly array of the material have already been commented on. Finally, in commending the bulletin to all who are interested in New Zealand farming whether they be in the country or the town, one feels that two improvements might be considered when, as the foreword suggests, the next edition appears. First, a brief bibliography might be appended either to the chapters as they appear or at the end. Secondly, an effort might be made to issue the publication as a book between board covers so that it may readily take its place on the bookshelf—standing erect on its own feet. It is well worthy of such consideration.—R. H. Bevin.

THE PACIFIC BASIN. By G. L. Wood and P. R. McBride. Melbourne. Oxford University Press. Revised and enlarged edition, 1946. pp. 393.

The interest of New Zealanders in the Pacific Area has been increased by the recent war. For the most part, however, we are still inclined to forget the strategic and economic value of areas which lie off the main shipping routes between ourselves and North America and Europe. We wonder why, so few years after the Atlantic Charter, Indonesians fight Dutch and Annamese fight French. We therefore welcome a new and revised edition of Professor Wood's *Pacific Basin* embracing as it does brief, regional studies of such areas as New Caledonia, New Guinea and the Philippines. This edition includes many new and excellent illustrations which alone make it a valuable addition to the geography library of a secondary school, and give it increasing appeal to the general reader.

The foreword and the other additions to the sixteen year old text, show that the authors appreciate to the full the effect of the last thirty years on the geography of the Pacific Area. Unfortunately there is less appreciation of the changes that have occurred in geographical thought during that period. This new edition still gives much space to Herbertson's 'natural regions' of the Pacific basin. It would appear that the authors themselves are doubtful of the value of such a division, as they become contradictory when justifying such a 'regional' study: thus 'The factors which make up a homeland, such as build, climate, soils, and water distribution, vary so greatly that the resemblances just mentioned lie deep rather than on the surface. Furthermore, the appearance and habits of peoples living in the same natural region have often nothing in common. The differences, however, will on closer study serve to emphasize the likenesses, and will help to show the effect of other than geographical factors. Only by study of this kind can man's own efforts to modify his homeland be understood. The racial stock from which the people spring, the sort of government they have developed, the past history of the region, its accessibility, and the conditions for transport form the background upon which must be shown the picture of life in different lands.'

The divisions employed here are based on climatic factors—the reference map is called a 'map of climatic regions'—and the use of the term 'natural regions' appears therefore quite unnecessary. Moreover, it is elsewhere claimed that 'it is more useful to study the Pacific Basin by natural regions rather than the political divisions we call countries,' yet in practically no case (in the study of the countries surrounding the Pacific Ocean) does the chapter heading coincide with a region as shown on the 'map of climatic regions'. In fact, the brief outlines of the geography of Asia and South America are given under the heading of political divisions; and although the North Island of New Zealand is shown as being in the 'cool temperate east coast' climatic region, and the South Island in the 'cool temperate west coast' region, the Dominion is treated as one in its regional study.

This arrangement however detracts little from the value of this book as a compact elementary text on the Pacific area. The bias of the most valuable part of the work is of course economic, as would be expected from these authors, one a professor of commerce and the other a lecturer in economic geography. Had the space allotted to the 'natural regions' been devoted to a fuller study of certain areas, or to some brief description of islands of minor economic but of considerable strategic and geographic interest—Wake, the Aleutians, the Riu Kius—it would have been still more welcome. For example, such areas as Sumatra, Siam and Indo-China, Borneo, Formosa, and Korea all occupy a greater place in the geography of the Pacific than would appear from this book; and the immense developments of recent years in agriculture, mining, manufacturing, and transport in Siberia, with their great significance in Pacific affairs, are barely mentioned. Any geographic study of the Pacific Basin would seem to need today to be built around a consideration of the vast population living on its edge. It would describe their vastly different standards of living. It would discuss the *exchange* of goods across this huge ocean; the exchange of *ideas* aimed at raising the living standards of the overcrowded peoples on the western rim closer to that of the southern and eastern peoples; the competition for raw materials which has led ultimately to the rise in strategic importance of some minor islands: the effects of the air age, particularly in the far north. These topics, rather than 'natural regions', would make this 'human and economic geography' of the Pacific Basin of even greater value.—J. L. HEWLAND.

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